Theory of Evolution in Dutch Education

History of the theory of evolution in Dutch public education, policy, debates and high school examinations from 1867 until recent

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‘Juffrouw Laps, je bent ‘n zoogdier’

(Multatuli, 1862)

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Personal Introduction

As a child I was already fascinated by fossils, shells and dinosaurs, remnants from times long past. I grew up in the most southern part of the Netherlands where during my childhood I had been shown ancient seafloors from the Cretaceous period that surfaced in the form of marls containing shark teeth and fossils of species that were now long extinct. My grandfather, his father and his grandfather (who is the man in image 0.1 – 'The coalminer' 1915 by Jan Toorop) had all worked as miners bringing up coals from the carboniferous period containing unfamiliar plant imprints. And sometimes I was woken up by the occasional earthquakes that occur in this area. These landscape features are unique to the otherwise muddy and clay covered Meuse and Rhine river delta that makes up our small sea-challenged country on the North-Sea coast.

(Image 0.1 'The Coalminer')

I also grew up in one of the most densely populated Catholic areas in all of the Netherlands, went to a Catholic high school and occasionally attended masses, funerals, weddings and baptisms in the large basilica or one of the many other Catholic churches. In school we were no longer taught 'religion' as a subject, as had long been the custom. But instead we had a subject called 'life philosophy' which turned out to be pretty much the same thing. The theory of evolution was dealt with in biology class, however briefly. It was not at all portrayed as the basic and all connecting principle of the natural science that is biology. So much for Wallace and Darwin.

I went on to study earth sciences at Utrecht University where I received my bachelor degree in 2008. I wrote my bachelor thesis on the subject of palaeoclimatology about the 'Influence of the North Atlantic Igneous Province on the Paleocene Eocene Thermal Maximum'. I then followed up on my bachelor with a master in biogeology, an interdisciplinary master that was a relatively new collaboration between the Utrecht faculty of Geosciences and the faculty of Biology. I graduated in 2011 with a thesis on the subject of Paleontology about a fossil horse genus called 'Evolutionary adaptation in the Spanish Anchitheriinae in relation to environmental and climatic changes'.

In 2010 I also started the master program 'History and Philosophy of Science', I learned about natural science history, great scientists, foundations of science and science philosophy. For me it was pretty obvious that my final thesis would be on the subject of evolution due to my background and interests. But since we had recently had the '2009 Darwin Year' with all its worldwide celebrations; books; television programs and publications, what was there left to do on the subject of evolution?

The debate on the theory of evolution in United States' public education has been widely discussed in books, papers and many articles, even a movie was made about the subject. The reception and treatment of the theory of evolution in Dutch public education however has not yet been extensively documented and discussed. In her 2006 master thesis Maartje Brattinga discusses the reception of the theory of evolution, and especially human Origins, in Dutch family magazines and schoolbooks from 1867 until 1974 (Brattinga 2006). In the following thesis I aim to present a much broader overview of the theory of evolution in Dutch education and discuss its history until the present day. For, even though the discussion has never been particularly fierce in the Netherlands, it is definitely ongoing.

Subject and Relevance

As stated in the subject introduction above the discussion about evolution in education is fiercer abroad, especially in the United States. It has also been mapped more closely there. In the Netherlands there have been a few moments when the discussion flared and became more visible in the public sphere but it has always been there. Especially after education became a political affair in the early years of the twentieth century (Leune, 2002). For the United States annual surveys are held mapping the acceptation of the theory of evolution within different ethnic, age, educational and even political focus groups. For the Netherlands hardly any such data exist.

Moments when the discussion did flare were for example the visit of the German biologist Carl Vogt to the Netherlands in 1868 (Brattinga, 2006). Also the activities of the Darwinyear in 2009 sparked the discussion again. For example when early in 2009 a leaflet was distributed to about 6,6 million Dutch households with the title 'evolution or creation, what do you believe?' (image 0.2). This was an initiative of the Dutch website 'creatie.info' and it was coordinated by Kees van Helden as an early response to the expected flow of pro-evolution information that would follow during the so proclaimed Darwin year 2009. Many people were outraged and the leaflet was in many cases send to be returned to the distributer and in some cases it was forwarded to Dutch Protestant churches (Petrovski 2009).

Image 0.2 from creatie.info

However it would still appear as if the Dutch generally don't care too much for this controversy. Therefore the discussion has always remained confined to for example academia and expert panels formed to advice governments mainly on educational issues. This may also be the reason why the situation hasn't been researched or mapped out very much and this the intention of this thesis.

Even though the Dutch don't seem too occupied with this problem in their daily lives the issue is still of great importance today, especially concerning education. Therefore mapping its history within the Dutch education is vital for understanding the current debate. A fairly recent political tug-of-war is played out over the central biology examination of which the content is determined by state law. It was present 'incognito' before, but in 1998 the term evolution was added to the so called 'exam program' specifically and it became compulsory to teach at every secondary school. Also added 'to balance evolution' perhaps was the word 'creation' which also made this topic compulsory to teach in biology class. Furthermore religiously based political parties have tried to prevent evolution from being included in the central final examination. Very recent changes in the biology exam program (2012) signal that a change is close at hand. But this discussion is far from over yet.

Part 1 – Introduction

Research questions

This thesis consists of a part literature research and a part primary sources research on old Dutch school methods. This thesis attempts first and foremost to provide a broad overview of the issue of evolution education in the Netherlands and everything that may be related to it. The second aim is to provide an insight in how the theory of evolution itself was received in Dutch education. A third objective is to find out how this can be placed in a historical perspective and what the role of the Dutch pillarization has been. In chapter three the United States is used as a case file in order to compare the discussion in the Netherlands to the issues that are important in the US. How do the two compare and how do they influence each other? Finally it will be discussed whether or not evolution may still be regarded as a difficult issue in Dutch education today by looking at the past 30 years of modern Dutch education.

The second part of the thesis will be a research on primary literature, namely Dutch school methods. Subjects important for evolution education have been selected as guiding principles for this research, these subjects are; human evolution, micro and macro evolution, religion, paleontology and genetics. Investigated will be how these topics are dealt with or how the influence the content of the books. Attempted will be to draw conclusions about the teaching of evolution in the Netherlands throughout the researched period that starts with the oldest book used in the research from 1867.

Research Material and Methods

For this thesis the secondary literature was acquired from peer reviewed journals if possible but also from popular scientific sites, popular scientific journals and renowned non peer reviewed journals. Personal communication with Dutch and American experts was also a valuable source of information. During my stay in the United States at the University of California Berkeley, I have spoken to actual participants in the so called Dover trials. This is one of the cases in which a school was sued by parents after they wanted to use an Intelligent Design textbook in biology class. My contacts were both called upon as expert witnesses to 'defend' the science of evolution and Darwin. I also spoke with experts at the NCSE, the National Centre for Science Education that is based in Oakland. In the Netherlands I have spoken to members of the different committees charged with the task of developing new exam programs for Biology.

For part two of this thesis primary literature was obtained. The ´Nederlands onderwijsmuseum´ (Dutch education museum) in Rotterdam has a vast collection of old schoolbooks covering many different school subjects including natural history, zoology, botany, biology and geography. I have selected a few methods and examined them looking for content on the theory of evolution (figure 4.1.1). school methods were selected often because on first glance it looked as though evolution was dealt with in a certain way. It was also attempted to select schoolbooks with a different religious background. It is important to note that the selection does not aim to be complete in any way, it is meant as a sample in order to say something about evolution in Dutch schoolbooks. It was also attempted to obtain books throughout the entire period of interest. This didn't succeed as much for

the more modern period because these books (past 30 years) are not yet part of the collection at the education museum. Thanks to Maartje Brattinga who had photocopies of many of the books in her possession. This research does not aim to give a quantitative overview of evolution in schoolbooks at all. It is attempted to give a short overview of the methods used in figure 4.1.1 but a complete quantitative report of all methods that were used in school during the researched time period would be beyond the scope of this research. A problem with looking at schoolbooks is that we do not know whether the material from the books was actually dealt with in class. The teachers were free to omit certain passages in their lectures and they probably often did and still do. So we cannot simply state that we know for certain that evolution was taught at certain schools from a certain point in time onwards but only that it was present in the school books. Other primary material used in this research consists of original law documents (www.rijksoverheid.nl) and secondary school final examinations obtained from (www.examenblad.nl) a database with all Dutch school exams.

Chapter 1 – A Brief History of Dutch Education

1.1 - A Compartmentalized Society

Even though the true compartmentalization of the Dutch society didn't start until the so called 'Schoolstrijd' (school conflict) in the early years of the nineteenth century the influence of some compartments or 'pillars' of society were already present and actively influenced education before this time. The humanists, or liberals, made a point of making schools accessible for the lower income classes of society. Free schooling was already available in the thirteenth century but this was only meant for boys who were to be educated into clergy. When in 1521 the Reformation was started by Maarten Luther this immediately had its effects on the education and school boards that had before been firmly in place as a purely Catholic stronghold (Boekholt and de Booy 1987).

In the early 1800's a conflict arose between the confessionals and the liberal government, called the Schoolstrijd. The main argument was over funding for public Christian schools, this triggered an emancipation movement from the Protestant church, the Catholic Church and later the working class. They all wanted state funding for 'their' schools and this led to the eventual compartmentalization, or pillarization of an entire nation. Almost all public affairs were henceforth divided into four pillars; the Catholic, the Protestant, the Liberal and the Social column. Sport clubs, health care, magazines, radio and later television network, newspapers and political parties all we exclusively organized for members belonging to each of these four columns. People hardly had any contact with people from outside 'their pillar'. A very important public affair that was thus separated as well was education. In 1868 the Dutch bishops declared that not only should Catholic children go to a Catholic elementary school, they should also attend a Catholic high school. The bishops mainly had a problem with the HBS (see glossary) with its liberal attitude towards religion and also because it taught this 'Godless evolution' (Brattinga, 2006). By the 1960's the compartmentalization had largely come to an end.

1.2 - History of Educational Law and Policy

First half of the nineteenth century- With the adoption of the first school law on the 6th of June 1801 education for the first time in Dutch history became a governmentally regulated affair. The effect of this regulation wasn't directly seen in every day practice. It had an effect on the long term improvements like the equipment of schools, quality of the teachers and the composition of the curriculum. Continued was the tradition of the class society in schools and also this first school law did not include an obligation to engage in education. This law was replaced in 1803 and again in 1806 a new law (appendix B) was passed that would hold until 1857. This new law awarded the state an even bigger influence on education than before. For public schools for example a detailed prescription regulated what books were to be used (Leune, 2002). Here it should be noted that the non-public schools retained their freedom in teaching and teaching material. However the definition of a public school differed from the definition that would be applied today. A public school was a school that was funded with public money, money from the churches was also counted to be public money, therefor the public schools back then also included the Protestant and Catholic schools. Non public schools were those who were not funded by public money. They were divided into two groups; the first class existing of institutions and school associations, the second class were the private schools. There were four types of public schools; the school for the poor, the repetition school, the second commoner public school and the first commoner public school. The early 1806 law also stated that education content should be regulated by the government to ensure that children were trained in all 'social as well as Christian virtues'. This is already a hint of the religious foundations that Dutch education was built on and still is connected with today. In 1814 an important article was added to the Dutch constitution (article 140 from the 1814 constitution) stating that:

> *.. Ter bevordering van Godsdienst, als een vaste steun van den Staat en ter uitbreiding van kennis in het openbaar onderwijs op de hooge, middelbare en lage scholen een aanhoudend voorwerp van de zorg der Regering..*
>
> .. As a stimulation of religion supporting the State to expand knowledge in the higher, middle and lower education is a concern of the government..
>
> (source: www.denederlandsegrondwet.nl)

In this 1814 article from the Dutch constitutional law it is again and more specifically stated that it is the task of the government to stimulate religion and religious values in all layers of the Dutch educational system. According to Leune (2002) the separation of church and state that had been implemented during the French occupation remained intact yet stimulating religion was still regarded as an important governmental task. The idea that religion should be a governmental task stems, according to Leune (2002), from the fact that the former Dutch republic was built upon a very strong Calvinistic foundation. The stimulation of religion was even seen as the main vindication for a nationally regulated educational policy.

Second half of the nineteenth and first half of the twentieth century- This Calvinistic religiously based and infused education changed when in 1848 the law of freedom of education (vrijheid van onderwijs) was added to the Dutch constitution. This law gives schools more freedom to have a

religious identity or political 'color'. This particular constitutional right will play a very important role in the discussion about the theory of evolution that follows. Because it also entails that there is a certain freedom to what a school may teach and this enables schools to teach creationism alongside evolutionary theory. There has even been a recent discussion about whether this constitutional right may even oblige biology teachers to the so called principle of 'equal time', teaching both evolution and creation (van Caulil 2005). The law on education of 1863 was especially important for the theory of evolution because this law stated that *natuurlijke historie* (natural history) was to be an official high school course. The liberals were happy about this, the confessionals less so (Brattinga, 2006).

In 1900 also the first law on compulsory education was passed. This obliged children from the age of 6 until 12 to follow primary education. Some children were excepted from this obligation such as farmer's children during wartime and also girls were excused to enable them to look after their family at home. Later this law was expanded in 1969 to nine years of compulsory education and in 1975 to ten years. 1917 is often seen as the year that the 'schoolstrijd' ended with the adding of article 23 (appendix A) to the Dutch constitution, sometimes called the pacification agreement. This constitutional article states mainly that Dutch education should strive effectively towards a consensus in the midst of diverging values and interests. This article is still influencing the construction of Dutch education today and it is exactly how the Dutch system differs greatly from for example the educational system in the United States where the first amendment states that religion should not play a role in public affairs like education.

Second half of the twentieth century - After a long period of newly found freedom in education that lasted roughly from 1848 until the end of the second World War a period of a larger presence of the government in education began. Many new systems and innovations in education are imposed by the government on the many different schools to which they should all adhere. Another relatively new phenomenon caused tension between the schools and the government. From 1975 onward schools have to deal with budget cuts imposed by the state. The content of constitutional article 23 is not revised; it is the interpretation of the freedom of movement by the government that changes. From this period on we also see many institutions rise that have the purpose to advice the government and to design innovations in education. This is called the 'educational infrastructure' and it creates an entirely new type of profession within the Dutch state; educational advisor. These institutions will be dealt with more in chapter 5 of this thesis. Before the governments influence on education becomes a topic of debate again during the end of the twentieth century the so called 'mammoth-law' was passed in 1968. This law is actually called 'wet tot regeling van het voortgezet onderwijs' (law on the regulation of secondary education) but it is called 'the mammoth' for short due to a rather peculiar comment a member of the Dutch parliament made. He said prior to the laws adoption about regulating the entire secondary education segment in just one single law: "let us just leave thát mammoth in the magic forest". The mammoth law interchanged the previously non-consecutive MULO, HBS, MMS, Lyceum and Gymnasium for just three different levels of secondary education. After the adoption of the mammoth law the three new levels were: vocational training (LBO, MBO, HBO), general secondary education (LAVO, MAVO en HAVO) and the academic preparatory education (Gymnasium, Atheneum, Lyceum) (see glossary).

Beginning of the 21st century - Near the end of the twentieth century the discussion about whether or not the government should have such a large influence on the educational system and its content flared, this starts already in the 80's. The current debate and the laws, policy and discussion of the past 30 years will be discussed in chapter 5. We see that two themes keep reoccurring in the Dutch

educational laws since they first appeared in the early nineteenth century; religion and freedom, or rather freedom of religion and identity. These are not only important values in the Dutch educational system but in the social framework of the Dutch society as a whole as well. Before the 1848 freedom of education law was passed it was established by law that the government should through education make sure that religion and religious values were upheld. Now that the background and history of Dutch education is set; let's take a look at this topic that has its foundation in religious antecedents and will come to play a role in this setting of educational freedom.

Chapter 2 –The Theory of Evolution

2.1 - Debates, Controversy and Revolution

Ever since Charles Darwin first published his book 'On the Origin of species' in 1859 the theory of evolution has been the topic of heated debates and controversy worldwide. This chapter aims to give a brief overview of the important moments, debates, revolutions and the ever present shadow of eugenics in the history of the theory of evolution. This overview will be a general and worldwide summary and it is attempted not to focus on any country in particular. The discussed subjects may have affected public opinion in different countries in a different way. In the second part of this thesis the Netherlands will be the central topic and this chapter's aim is to set the stage.

The fact that the history since 1859 is discussed here does not mean that the evolutionary traditions and thus also the controversy and debates were not around before that time. Some evolutionary views even existed alongside Darwinism for a while and they still do exist. David Depew (2009) identifies 3 non-Darwinian approaches to evolution; There is Herder's (Johann Gottfried Herder) intuition that mother nature is like a womb giving birth to new kinds in a way that parallels the ontogeny of individual members (Zammito, 2002). Then there is the Lamarckian theory of adaptation that contests Darwin's natural selection. Third the principle of 'saltationism' (Latin for leap or jump) was added to Etienne Geoffroy Hilaire's structuralist view (all life is based on a single unity of plan). The basic principle of saltationism was also used in the synthesis of the late nineteenth 'mutation theory' by Huge de Vries contesting Darwin's gradualism (Depew, 2009. p 326). It is important to identify these non-Darwinian views (Herderian, Lamarckian and Geoffroyean) of evolution since in the public sphere they are often unjustly used interchangeably. But also because modern discoveries about the genome have lead to the revival of these theories in scientific circles (Depew, 2009. p 327).

One of the earliest public debates on Darwin's theory took place not long after the publication of the 'Origin' in 1860 and it would henceforth be known as the Wilberforce-Huxley debate. Samuel Wilberforce, Bishop of Oxford, asked Thomas Henry Huxley, who was later to be known as Darwin's bulldog, whether he was related to an ape on his grandmother's or his grandfather's side. Huxley famously replied something along these lines: "I would rather have a miserable ape for a grandfather than a man highly endowed by nature and possessed of great means and influence and yet who employs those faculties for the mere purpose of introducing ridicule into a grave scientific discussion. I unhesitatingly affirm my preference for the ape" (Huxley to Frederick Dyster, September 9, 1860. Quoted in Depew, 2009. p 337). Arguably this may be seen as the day that Huxley first positioned Darwinians as defenders of science against the clerical power (Depew, 2009. P 338). In the early

1900's Darwinism appeared to be in trouble again when Hugo De Vries's theory of mutation could not explain gradualism. This was solved by the mathematical expansion of Gregor Mendel's heritability laws of an inbreeding population by means of the so called 'Hardy-Weinberg Equilibrium Formula' (Depew, 2009. p 351).

2.2 - Influence on Public Opinion

The theory of evolution is a unique subject that exists on the boundaries of the public-political, scientific and personal-religious spheres. Therefore scientific debates about the theory of evolution can have a major impact on public opinion and politics. The public opinion determines the political course and in many countries education is a governmental affair. In this way the public opinion about evolution will, with a certain delay, also influence the way evolution is handled in education. Therefore it is important to know which major events in the history of the theory of evolution influenced the public opinion in what way. In this paragraph an overview will be presented of how the historical events in the previous paragraph have had an impact on the contemporary but also on later public opinion.

Evolution has been news from the start. On March 28, 1860, the *New York Times* ran a massive article on the newly published *On the Origin of Species* (Zimmer, 2010. p 236). Evolution was present in the public sphere almost immediately. In the same year the Wilberforce-Huxley debate was not only an important debate in the scientific community, it also had a huge impact on the public perception of the theory of evolution and of the debate about it. Most public controversy about the theory of evolution has always had to do with the topic of human evolution. This is to be expected since this is the thing that comes closest to the personal and also the religious sphere. In many religions humans are considered something completely separate from animals. During the Wilberforce-Huxley debate human evolution was a central aspect. Huxley's statement unintentionally forever fixed the notion in the public's perception that it was Darwin's idea that humans directly descended from contemporary apes and monkeys rather than from and extinct ancestor of both (Depew 2009. p 339). This idea is still a very common and persistent misconception among common people when asked about evolution. But this is far from the only problematic concept of the theory of evolution in the public arena. Very early in the history of Darwinism the shadow of 'Social Darwinism'; 'Applied Darwinism' or 'Eugenics' appears. This started when in later editions of the Origin Darwin added to 'natural selection' the phrase 'survival of the fittest'. This had a large impact on the public and it led them away from Darwin's own originally romantic notion of nature. Huxley's book 'The Place of Man in Nature' didn't do much to help this. In 'The Descent of Man' (1871) Darwin was trying to steer the public opinion away from the dog-eat-dog conception of nature by stating his ideas about the altruistic behavior organisms show when they are part of a group (Depew, 2009. p 341). Unfortunately the notion remained and it was later extended to races and also became an argument for imperialism. The public reception of Darwinism, and especially the notion of Social Darwinism, can be assesed rightly when viewed in the contemporary framework. The issues that were agitating the European and North American public were violent conflicts between labor and capitalistic parties; imperialistic wars; worries about intermarriage between whites and other races and immigration and eugenics proposals by governments (Depew, 2009. p 343). Much later it would be the holocaust that left a very dark mark on the Social Darwinism and Darwinism in general which will, for a long time to come, be etched in the public's mind. Efforts were made to untie Darwinism from eugenics not only by Darwin himself.

Dobzhansky in 1937 showed that natural selection is more of a creative force than a merciless executioner because it is impossible to identify the fit and the unfit. Differences, Dobzhansky and his successors argued, are not necessarily defects. This undermined the whole idea of eugenics (Depew, 2009. p 352).

But the taint of eugenics never really left Darwinism. In the later part of the nineteenth century Darwinism was already beginning to get a bad name with the general public. The turn of the twentieth century then saw the beginning of the emotionally charged public-sphere discussions about evolution in the United States. This is mainly an ongoing debate between fundamentalist Christians, creationists, and proponents of evolution that is played out in America's public education (see chapter 3). At the centennial of the Origin in 1959 there were high hopes among scientists about the public acceptance of evolution due to the development of the modern synthesis (Smocovitis, 2000. in Depew 2009). The efforts met, according to Depew (2009), with some success at least. But doubts about whether Darwinism could deal with the emerging picture of the genome lead to the revival of neo-Herderian, neo-Geoffroyean and neo-Lamarckian theories in science (Depew, 2009. P 327). In popular culture the merger between Darwinism and mutationism added another bad and frightening image to the already long list that existed in the public's mind. Japanese movies about mutated creatures as a result of the atomic bomb made mutationism into something much bigger and scarier than it actually was (Depew, 2009. p 351). The rise of population genetics put a stop to these wild ideas because the larger the mutation the less likely it is to enhance fitness. The shift to population genetics also screened evolutionary processes off from developmental evolution. This freed Darwinism from the baggage that it had collected from Heackel's recapitulation theory (Depew, 2009. p 352). Depew argues that it also freed Darwinism from the popular imputation that is was committed to evolutionary progress. He also states that this new kind of Darwinism unfortunately largely failed to affect the popular image (Depew, 2009. p 352).

Near the end of the twentieth century it was again Huxley who caused an uproar now not in the scientific community but this time mainly in the general public. When he gave a speech in Chicago it was expected that he would follow along the lines of Dobzhansky's idea of human evolution and help Darwinism shed its unfortunate connections with imperialism, racism and eugenics. And that Darwinism could be seen as religion friendly as it was a friend to human rights and human dignity. Huxley however, insensitive to the delicacy of the American situation gave a speech about a techno-scientific man who must take God's place in directing evolution thereby freeing humans from any residual need for religion. This speech was very offensive to the American public that it was the opening shot to a new anti-Darwinian war after the long post-Scopes (see chapter 3) truce (Depew, 2009. p 354).

Just as there was talk of Darwinism's eminent demise in the early 1900's due to a lack of a way for mutationism to explain gradualism, in the early 2000's there was also talk of the end of Darwinism. This time it was about the idea that all of Darwinism stands or falls with the adequacy of the modern synthesis. Seen by some as the 'new creationists', the Intelligent Design (ID) movement (see chapter 3.2), jumped to this change in the public attitude towards Darwinism's accuracy and flooded the public sphere with books saying that the current stress and strain within the current evolutionary theory are strong enough to justify a return to pre-Darwinian thought (Depew, 2009. p 327). The history of the Intelligent Design movement preludes this event but falls outside of the scope of this summary. Genocentric Darwinians replied that the new theory (organisms exist for the sake of their genes) perfects the modern synthesis, not imbalances it (Depew, 2009. p 327). The ID proponents

continue their attempts to imbalance Darwinism by bringing old debates like the missing links, and gradual vs. sudden change back into the public sphere. Their arguments are often founded in the fact that there are things in Darwinism that scientists were also 'wrong' about and changed their minds about later. Debates like the missing links and other things, long ago solved by science, are still close beneath the surface of the public's mind. It was the late Stephen Jay Gould, one of the best popular science writers of all time, who let the public in on these debates within the scientific community. This proved to be more food for the eager ID proponents and creationists because it showed that there was also disagreement about some aspects of the theory of evolution within the scientific community itself. This even lead to the accusation by several of his contemporary Darwinians that Gould was actually a creationist lobbying against evolution (Depew, 2009. p 329). Since they observed what happens when you try to explain the scientific discussion to the general public so called modern 'Ultra-Darwinians' (term coined by Eldredge and Grene, 1992) have instead taken to the 'in-your-face' rhetoric that is also used by the creationists. It is arguable whether this is a very effective approach and it is a hot topic of debate within the field of science communication today. The 'new modern synthesis', or as some argue the replacement of the modern synthesis, Evolutionary and Developmental Biology (Evo-Devo) with novelties like epigenetics is also reaching the public via modern scientific articles online in scientific magazines and newspapers. Evo-Devo is the science that researches ancestral relationships and evolutionary development, epigenetics researches heritable changes in gene expression or cellular phenotypes. It is hard to say something (yet) about how this may change popular opinion about evolution today but we can conclude that these texts, most often in popular scientific form, reach only a small specific part of the population; the young and higher educated members of society. This would be a very interesting thing to look at though because epigenetics is arguably the Lamarckian process of evolution at work, and Lamarckism is arguably already embedded in popular belief anyway. Geraedts and Boersma (2000) however argue that at least in student preconceptions of evolution Lamarckianism is actually hardly found.

Chapter 3 – Case File: The United States

3.1 - History of Evolution in U.S. classrooms

The historical start of the controversy around the teaching of evolution in the United States is seen as the *Scopes v the State of Tennessee* trial that will be known throughout history as the 'Monkey Trial' in 1925. John Thomas Scopes went on trial in Dayton, Tennessee for breaking the state's law prohibiting the teaching of evolution. Attempts to ban the teaching of evolution in the United States had started around 1922. Before this time the teaching of evolution was not problematic, so what changed? After Charles Darwin published the *origin* in 1859 Asa Gray, leading botanist and president of the American Association for the Advancement of Science became Darwin's chief advocate in the United States (Gillis, 1994. p 654). Gray himself was a self proclaimed evangelical Christian (according to Eugenie Scott of the NCSE), so that wasn't an issue at the time. All seemed fine but in the early years of the twentieth century the American Christians started rising against evolution. Their ideas ranged from a literal interpretation of Genesis and young earth creationism to believing in the principle of evolution but without natural selection. American religious fundamentalism was born. This uprising coincided with the so called progressive school movement, the public school movement emphasizing the need for compulsory attendance at public institutions. Enrollment in the nation's schools increased from about two hundred thousand in 1890 to two million in 1920 (Depew, 2009. p 192). Many more students went to High School than ever before, where they would be exposed to the teaching of evolution. The idea that their children would be exposed to this godless evolution outraged parents who in turn prompted more than forty anti-evolution bills in twenty one states. These bills were passed in Tennessee, Mississippi, Arkansas, Oklahoma and Florida (Depew, 2009. p 192). This was the scene in which the Scopes trial was set. A fact that is often ignored when discussing the triumph of science over religious extremism in this case is that Scopes actually lost the trial. The defense lawyer had asked the jury to return a guilty verdict so the case could be appealed to a higher court. The case was never retried because the Tennessee Supreme Court overturned the lower court's decision on a technicality (Gillis, 1994. p 654). In fact, the law that drove the case wasn't repealed until 1967. After the Scopes trial evolution disappeared as a centerpiece of biology textbooks and evolution was taught less in schools until the 1950's. Evolution made it back into the classroom during the science education reform that followed the launch of the Sputnik by the Soviets in 1957 (Gillis, 1994. p 654). The fact that the Russians were first to launch a rocket into outer space promted the Americans to invest more in their science education. In 1968 science got another boost when in the *Epperson v. Arkansas* trial it was determined that the teaching of creationism violated the 'Establishment Clause' of the 1st Amendment of the United States Constitution:

> "Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the government for a redress of grievances"
>
> (www.civilliberty.about.com)

In this case it was a school teacher Susan Epperson who sought to invalidate the state law that prohibited all teachers from discussing the theory of evolution. This victory for the proponents of evolution was only the beginning of the ingenuity and perseverance of the antievolutionists. The outcome of the *Epperson v. Arkansas* case is very important for all court cases and actions that will follow, because now the Supreme Court had ruled that the government may not be hostile toward but may also not promote one religion or non-religion. In 1971 the Supreme Court developed the so called 'lemon test' to determine whether the Establishment Clause is violated by school policy. School boards must prove that they neither advance nor inhibit religion (Gillis, 1994. p 655). Another way creationists attempted to get a foothold in education was by demanding textbook stickers or disclaimers to be put in biology textbooks discussing human origins. In 1996 Alabama embraced this approach and also Louisiana, Oklahoma, Arkansas and Georgia considered the stickers (Borenstein, 2008). In the 1997 *Freiler v. Tangipahoa Parish Board of Education* trial the Louisiana Eastern District Court rejected a policy requiring teachers to read aloud a disclaimer whenever they taught about evolution.

3.2 - Creation Science and Intelligent Design

Now that the advance of religion was prohibited by the Establishment Clause it was time to disguise the wolf in sheep's clothes; 'creation science' was born. The antievolutionist's next move was not to try and ban evolution but to push for equal time treatments for both 'theories'. This equality argument has always been particularly effective among many Americans regardless of their personal position on evolution/creation because the U.S. has historically placed a very high value on fairness, freedom of speech and related 1st Amendment rights (Smith, 1995. p 27). Arkansas and Louisiana were two of the states that passed a 'balanced treatment' statute. In the 1982 *McLean v. Arkansas Board of Education* trial this law was invalidated because it violated the Establishment Clause, the case never made it to the High Court. Louisiana's law required creation science to be taught in schools where evolution was taught. In 1987 the Supreme Court in *Edwards v. Aguillard* also shot down Louisiana's balanced treatment because it also violated the Establishment Clause. Until it was abandoned for Intelligent Design around 1987, creationists kept working on making 'Creation Science' sound as scientific as possible by adding the science buzzwords and focusing on the 'scientific' evidence against evolution. Some of this material was written by people with a high-level training in the sciences. People with no scientific background and even teachers could be swayed into thinking that it was genuine science. The more the creationist arguments sound like science, the harder they will be to fight in court. "The 1st Amendment does not protect us from bad science" says Eugenie Scott (Gillis, 1994. p 655). The Intelligent Design movement started in the late 1980's clearly as a replacement for the not so successful Creation Science movement. Underlying the ID viewpoint is a nineteenth century British theological view called 'the argument for design' (NCSE, 2008). The essential element of the ID philosophy is that complex structures (like the vertebrate eye) cannot possibly be the result of evolution but show the hand of a creator. They term they use for this argument is 'irreducible complexity' (Le Beau, 2007. p 195). Intelligent Design proponents have also argued for equal time in U.S. schools. This has resulted in for example the 'Church of the Flying Spaghetti Monster', founded in 2005 (image 3.2.1). This movement started when Bobby Henderson, a 24 year old Oregon State University physics graduate, wrote an open letter in 2005 protesting the decision by the Kansas State Board of Education to permit the teaching of Intelligent Design as an alternative to evolution. In the letter he parodied the concept of ID by professing his belief in a

supernatural creator that most resembled spaghetti and two meatballs (image 3.2.1) pleading for equal time in classrooms for the flying spaghetti monster alongside ID and evolution (Van Horn, 2006). After this 'Pastafarianism' quickly became a worldwide internet phenomenon and an 'actual' religion proclaiming Bobby Henderson as their prophet. The FSM religion became an international symbol against ID and Creationism. Apart from moving for equal time the ID movement also sought to develop a scientific research program, most notably the Discovery Institute in Seattle. There they seek to scientifically prove the element of design in nature. Most scientists agree that such proof is impossible and that therefore Intelligent Design is not, and never will be, a science (Le Beau, 2007. p 195). In the 2005 *Kitzmiller v. Dover* case the constitutionality of teaching Intelligent Design was first challenged. The judge ruled that "ID cannot uncouple itself from its creationist, and thus religious, antecedents".

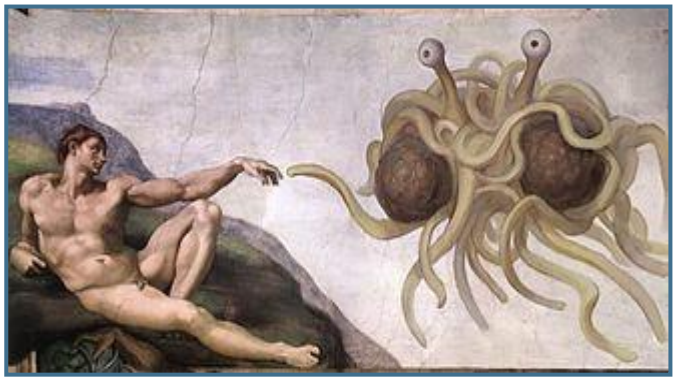

Image 3.2.1 'Touched by His Noodly Appendage'

3.3 - Stealth Creationism and Recent Polls

The Creationists however did not give up after this blow for ID. After Creation Science and Intelligent Design the latest creationist endeavor arose around 2005. Creationists with a science background work to get their articles published in peer reviewed scientific journals. These articles however have a creationist message or they aim to undermine essential elements of the theory of evolution and other 'problems' with the creation myth. Often these articles appear not to be recognized as such and the creationists will then point to these articles that were accepted by the scientific community as evidence of problems within scientific theories incompatible with creation, like evolution. This new form of creationism was therefore dubbed 'Stealth Creationism' by Steven Newton (NCSE) in 2005 (personal communication Steven Newton, 2012). This new 'trend does not limit itself to antievolutionism only. For example Creationists, sometimes even with a PhD degree in geology, will try to publish articles on the only aeolian (wind-formed) deposit in the Grand Canyon because it stands in the way of the 'Flood Theory' explanation of the origin of the Grand Canyon. They will use sound looking scientific arguments challenging the wind formed cross bedding in the *Coconino Sandstone* formation and try to explain it instead as a flood deposit (personal communication Steven Newton). Another example of Stealth Creationism is the attempted publication of an article in early February 2008 by two creationist authors. The first red flag was the title of the article submitted to the Journal Proteomics: 'Mitochondria, the missing link between body and soul: Proteomic prospective evidence'. Steven Salzberg (2008) notes that: "Much of the paper reads like any review paper, with considerable technical detail and 239 references to the literature". Most red flags during the online prepublication of the article were raised at one passage however*:*

> "More logically, the points that show proteomics overlapping between different forms of life are more likely to be interpreted as a reflection of a single common fingerprint initiated by a mighty creator than relying on a single cell that is, in a doubtful way, surprisingly originating all other kinds of life" (Warda and Han, 2008).

Had the authors been more careful not to explicitly name the creator in their article they might have even succeeded says Salzberg (Salzberg, 2008). Marin college geology professor Steven Newton warns in a talk given before the Bay Area Skeptics that these articles may make it and may even already have made it into peer reviewed journals if reviewers are negligent (Berkeley, February 2012).

In the United States, unlike in the Netherlands, yearly public opinion researches on the topic of evolution and religion are held. These polls even make a division between different groups in society. They take into account social class, level of education and sometimes even ethnicity. The Dutch bureau for public statistics and the Dutch cultural planning agency (CBS, CPB) report that no such research has ever been conducted or is planned for the future (source: personal communication CBS and CPB). The only research that takes the Netherlands into account on this topic is a 2006 research by Miller, Scott and Okamoto (figure 3.3.1). This research puts the United States at the bottom of the list comprised mainly of European countries and also Japan, only Turkey scores lower. Of course it is important that most Islamic countries, most other Asian and also African and South American countries are not represented in this research. In their 2006 Science article Miller et al. attempt to explain the 'low' score of the United States in this list of mainly Western countries. First they point to the American fundamentalism as a cause. Historically the beliefs in the U.S. fundamentalism differ from those of mainstream Protestantism in both the U.S. and Europe. Mainstream Protestantism views Genesis as metaphorical and like the Catholic Church have not seen a major contradiction with science. Second, the evolution issue has been politicized in the United States and incorporated into the current partisan division. This is not seen in for Europe or Japan. The American Republican Party has adopted creationism as a part of their platform mainly to appease voters in the Mid-Western (also called the red) States. A third thing that may cause the low acceptance of evolution in the US is the level of 'genetic literacy'. A low understanding of genetics may add to a low acceptance of evolution. (Miller et al., 2006)

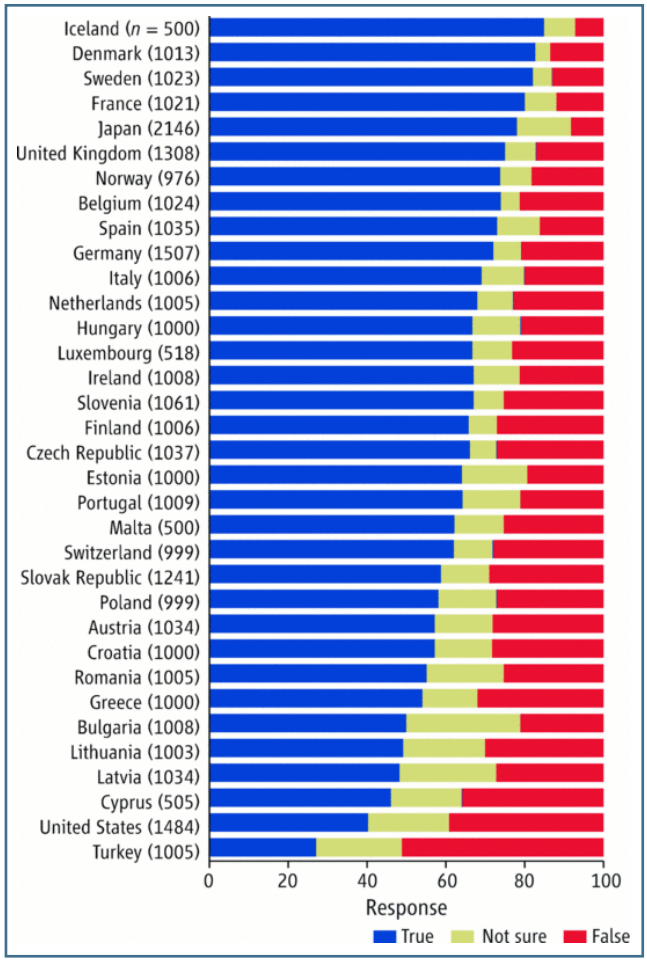

Figure 3.3.1 – Acceptance of Evolution Miller et al. 2006

The most recent Gallup poll (www.gallup.com) on the public opinion about evolution in 2010 shows that the rate of acceptance of the theory of evolution within the United States may be slightly higher than previous years (NCSE, 2010). To the question 'which of the following statements comes closest to your views on the origin and development of human beings', 38% accepted that 'human beings have developed over millions of years from less advanced forms of life, but God guided this process', 16% accepted 'human beings have developed over millions of years from less advanced forms of life, but God had no part in this process' and 40% accepted 'God created human beings pretty much in their present form at one time within the last 10.000 years or so'. The percentage of participants accepting the answer that human beings evolved without the interference of God rose from 9% in 1982 to 16% today. The amount of participants accepting a pure creationist explanation for the origin of man is with 40% the lowest amount ever measured in Gallup's history of asking this question, it came down from 47% in 1991, 1993 and 1999 (figure 3.3.2). Yet these changes are not very substantial, the basic structure of belief about the origin of man in the United States is generally the same as it was in the early 1980's states Gallup (NCSE, 2010). They also concluded that the acceptance of the creationist option was associated with a lower degree of education, a higher rate of church attendance and affiliation with the Republican Party. If the ratios in the other countries of the 2005 poll also haven't changed too much it can be concluded that the United States still dangles somewhere at the bottom of this list.

Response	1982	1991	1993	1997	1999	2010
Special Creation (10.000 years ago)	44%	47%	47%	44%	47%	40%
God guided Evolution	38%	40%	35%	39%	40%	38%
Evolution without God	9%	9%	11%	10%	9%	16%
No response	9%	4%	7%	7%	4%	6%

Figure 3.3.2 - Summary Gallup Polls – 1982, 1991, 1993, 1997, 1999 and 2010. Source NCSE.

3.4 - Creationism and ID in the Netherlands

As stated in the previous paragraph no such regular polls are held in the Netherlands so there are no statistical data about creationist beliefs concerning evolution apart from the (Miller et al., 2006) data. So what role does Creationism and Intelligent Design play in the Netherlands? Even though all seems to be fairly quiet, according to Flipse (2012) the Netherlands can still be regarded as a hotspot in the debate about creation and evolution or as some prefer to call it 'a frontline in the creation-evolution battle'. The reason that this may be counterintuitive is the fact that the discussion amongst theologians and scientists mostly took place within the confines of the Calvinist/Protestant community and later 'pillar' and not in the public sphere. Flipse (2012) states that the American young-earth creationism has strongly influenced the Dutch anti-evolution movement since the 1970's. How is it possible that an 'American idea' that developed in an entirely different cultural and theological context could so easily take root in the Netherlands? For this we need to take a look at the history of the Dutch (neo)-Calvinists. In this group the support for young earth creationism within the Netherlands is largest. The Catholic Church has always been relatively tolerant towards evolution. However the Protestant Church also has never been hostile towards science as such. It was in fact the one of the Calvinist movements who in 1880 founded their own 'Free University' in Amsterdam (VU Amsterdam). Initially it comprised of the Faculties of Theology, Arts and Law but in 1930 a Science Faculty was added (Flipse, 2012). The foundation of this 'Christian Science' however was different from mainstream science. Their charismatic leader Abraham Kuyper (1837-1920) regarded Calvinism

as an all encompassing worldview that also included science. He accepted the concept of evolution, but was a supporter of 'divine evolutionistic creation'. In a way he was an early supporter of the Intelligent Design concept of evolution. A recent paper by the geologist Davis A. Young (2009) argues that the Dutch Calvinists may not have been so lenient towards science and that they were actually rather suspicious of mainstream geology. It is generally known that nineteenth century Scottish and United States Calvinists were favorable to the idea of an ancient earth (Flipse, 2012). But Young is surprised at the attitude of their fellow Dutch believers and even wonders if there may have already been something like an independent young-earth-creationist movement in the Netherlands in the late nineteenth century (Young, 2009). International contacts have always been important to the Calvinists just like they were for the Roman Catholics or Anglicans and there was a natural bond with the Dutch immigrants in the United States (Flipse, 2012). The Dutch Calvinist immigrants and their descendants are actually an important group in the United States creationist movement even today (Personal communication Nicholas Matzke, NCSE). These networks between the international groups of Calvinists, especially with the Americans, offered possibilities of exchanging ideas. This exchange became an important factor in the debate about evolution in the Netherlands (Flipse, 2012). Dutch creationism, according to Flipse, even though it cannot be understood without taking into account the local cultural context should always regard the Dutch-American connection.

Intelligent Design was introduced into the Dutch public sphere by physicist Cees Dekker. Indirectly he was also the cause of a political row in 2005 when Maria van der Hoeven (Dutch secretary of Education at the time), after talking to Dekker, expressed her hope that ID may eventually be incorporated into the Dutch school curriculum (Blancke, 2010. Flipse, 2012. 't Hoog, 2005. Van Caulil, 2005). Creation can be discussed in schools says Dutch parliament member Bert Bakker (D66), but not in biology class (interview by van Caulil, 2005). The American Intelligent Design proponents were very pleased with this development in Dutch politics. William Dembski wrote on his website *uncommondescent.com* that "there are further indicators that ID is internationalizing" (Blancke, 2010). In 2007 the incident with secretary van der Hoeven was one of the things that instigated the formation of a resolution by the European Union in 2007 (assembly debate 4 October 35th sitting) (Appendix C). This resolution warned against 'the dangers of creationism in education'. In the Netherlands many of Dekker's books on ID caused some uproar upon their release and sparked the discussion in the different media several times. Dekker wasn't the only public figure who openly supported ID, television personality of the Dutch Evangelical Broadcaster (EO) Andries Knevel is a well known proponent of ID. He started out in the early 1970's by promoting young-earth creationism on the Dutch television but gradually shifted towards a more 'evolution friendly' approach resembling ID. He later apologizes to his viewers for leading them astray by promoting both young-earth creationism and ID seemingly at the same time (Blancke, 2009). This of course caused some commotion among the predominantly young-earth creationist viewers of the EO. By the year 2007 both Knevel and Dekker had expressed some doubts on the topic of Intelligent Design, Dekker even started calling himself an 'evolutionary theist' and Knevel put himself somewhere between both Dekker's position and ID (Blancke, 2009). Another action by the Evangelical Broadcaster in 2007 drew a great deal of media attention. Gerdien de Jong, an evolutionary biologist at Utrecht University, published an article on the website *evolutie.blog.com* in which she revealed that the EO had deliberately altered the BBC documentary they broadcast called 'The Life of Mammals'. They had edited out all of the references to evolution and cut the episode on human origins entirely without informing their audience (Blancke, 2009). In 2008 in the run-up to the 2009 Darwin-year on the occasion of Darwin's bicentennial the Dutch young-earth creationists became very active again. When they realized that the occasion would

not only be celebrated in the scientific community but also in the public arena they initiated several projects to counterbalance the impact of the festivities. One of these projects is also discussed in the introduction of this thesis. In November of 2008 Kees van Helden was rallying financial support for the distribution of his pamphlet 'Evolution or creation, what do you believe?' The pamphlet was to be delivered to every household in the Netherlands; it was distributed on February 12th 2009 the exact 200th anniversary of Darwin's birth. Many responded in anger and Utrecht University students (Utrecht History and Philosophy of Science masterstudent Coen Brummer amongst them) responded by selling mailbox stickers that read 'Creationism, no – Darwinism, yes' (Image 3.4.1).

Image 3.4.1 – Mailbox sticker designed by HPS masterstudent Coen Brummer (among others)

It can be concluded that in the Netherlands creationism is very much present underneath the surface and that sometimes it is brought out by political discussions like in 2005 or like in 2009 by the media attention around the Darwin-year festivities. Even though the Dutch pillarization ended in the 1960's still many discussions, amongst which the discussion about evolution, are very much alive within the respective groups that make up the Dutch society. They will continue to come to the public sphere now and then but they definitely still play a large role in the background and in politics also behind the school curriculum.

Part 2 - Teaching Evolution in the Netherlands

Chapter 4 – Evolution in Dutch Schools

Even though evolution first appeared in Dutch schoolbooks in 1913-1918 it took until 1998, when the new school law 'de 2e fase' (see glossary) was implemented, until the term evolution was included literally in the exam program for biology. This is extremely late considering that the book in which the theory is presented to the public by Charles Darwin appeared in 1859 and that already in 1918 authors of schoolbooks were aware of its importance in biology and education. This is another clue that the discussion around the topic of evolution in Dutch schools was and still is more complicated than one might think. In this chapter an overview is presented of evolution in Dutch schoolbooks.

4.1 - School Subjects and Material

The topic of evolution can be expected to appear in school methods for the following Dutch school subjects; *natuurlijke historie* (natural history), *dierkunde* (zoology), *plantkunde* (botany), *geografie* (geography), *algemene natuurwetenschappen ANW* (general natural sciences) and *biologie* (biology). Of these subjects only the last two are currently still compulsory school subjects in the Dutch high schools and ANW is a fairly recent subject (the very recent subject NLT is excluded in this thesis). Only since the 1980's the government is actively involved in determining the content of Dutch school books, before that time authors were free to do pretty much whatever they wanted (Brattinga, 2006). As stated in the method introduction the teachers were also free to teach from these books what they wanted. So even if evolution is present in a schoolbook it is impossible to claim that this means that it was also taught in that particular school at that time.

When in 1863 the subject 'natuurlijke historie' was added to the Dutch school curriculum the confessionals weren't too keen. They were afraid that this would lead to the coverage of what they referred to as 'that ape theory' in school. However Maartje Brattinga concludes in her 2006 thesis on the reception of the theory of evolution that the theory wasn't implemented in schoolbooks right away. It took until 1913 for evolution to first appear in a Dutch schoolbook. In the 1913 method by A.J. Pesch for the subject zoology, evolution is still dealt with implicitly. They discuss the increasing complexity of organisms over time but they omit the mechanism for this. In 1918 the first method that Brattinga (2006) concludes was explicit about evolution appears. This was a method for the subject zoology by A. Schierbeek and D. Valkema, they discuss the Darwinian theory of evolution. During the first half of the twentieth century the lessons and methods dealing with evolution are very diverse, concludes Brattinga. It much depends on the religious views of the schools themselves. Schools with a religious foundation had more trouble with teaching evolution than the moderns.

The following figure is a compilation of data from the primary literature research on selected methods made available to me via the *Onderwijsmuseum* (Education Museum) in Rotterdam and also the collected material from Maartje Brattinga. The schoolbooks that were looked at are designed for several layers of Dutch secondary education. Most are intended for the HBS (higher burghers school), the MMS (medium level secondary education for girls), the Gymnasium (highest high school level) but also for the lower levels education (MULO) (see glossary). The methods were selected because they handled evolution in some way. It was attempted to include in the sample books that were published in a period of roughly 100 years between the 1870's and the 1970's. The newer methods are subject to the recent discussion and law and policy and this will be discussed in chapter 5 whereas in the older methods authors were much more free. It was attempted to look at methods with different religious characters as well as methods without a religious signature. This research does not aim to present a quantitative overview of how many methods dealt with evolution and when statistically, the museum's collection is too limited for and this would exceed the purpose of this study. The different school methods were analyzed in the following way; what was the approach to human evolution, are genetics discussed and what is the approach to micro versus macro evolution? It is also interesting to look at whether or not the authors discuss paleontology and ancient fossils in the light of evolution. The figure (4.1.1) is arranged by subject, then author, then year.

Subject - Author - Year		Religious	Human evolution	Micro	Macro	Genetics	Paleontology
Natural history							
Fortman, Heidinga	1936	Prot	No	Yes	No	No	Human fossils
Fortman, Heidinga	1937	Prot	No	Yes	No	No	Fossils,
Fortman, Heidinga	1951	Prot	(No)	(Yes)	(No)	No	Fossils, stratigr
Fortman, Heidinga	1954	Prot	No	Yes	No	No	Human fossils
Smeets	1935	Cath	No	Yes	No	-	-
Smeets	1935	Cath	No	Yes	No	-	-
Arenors	1880	No	No	Yes	Yes		Fossils, stratigr
Biology							
Smeets	1951	Cath	No	Yes	No	-	-
Van Biezen	1952	No	Yes	Yes	Yes	Yes	Fossils
Kreutzer	1968	No	Yes	Yes	Yes	Mutation	Fossils, stratigr
Van Schaik	1936	No	Yes	Yes	Yes	Yes	-
Gaay Fortman	1974	Prot	Yes	Yes	Yes	No	Fossils, stratigr
Gaay Fortman	1979	Prot	No (?)	Yes	Yes	Mutation	Fossils, stratigr
Geography							
Bos	1910	No	-	-	-	-	Fossils, stratigr
Bos	1921	No	-	-	-	-	Stratigraphy
Zoology							
Fortman, Heidinga	1951	Prot	No	No	No	No	Fossils, stratigr
Fortman, Heidinga	1955	Prot	No	No	No	No	(Fossils, stratig)
Fortman, Heidinga	1960	Prot	No	No	No	No	Fossils, stratigr
Fortman, Heidinga	1969	Prot	Yes (mentioned)	Yes	No	No	Human fossils
Hoogeveen, Peeters	1919	Yes	No	No	No	No	No
Hoogeveen, Peeters	1945	Yes	No	No	No	No	Fossils
Van Pesch	1913	No	No	No	No	No	Paleontology
Rombouts	1875	No	No	Yes	No	No	No
Schierbeek-Valkema	1922	No	-	-	-	Yes	-
Schmeil (Buekers)	1899	No	No	No	No	No	No
Schmeil (Buekers)	1915	No	Y –Origin unknown	Yes	Yes	Yes	Fossils
Smeets	1926	Cath	No	Y(?)	No	No	No
Thome	1889	No	No	Yes	(No)	No	Fossils
Thome	1915	No	(No)	(Yes)	No	No	Paleontology
Thome	1928	No	-	-	-	-	Fossils, stratigr
Ritzema Bos, Bos	1942	No	No	No	No	No	-
Zoology and Natural Hist							
Schierbeek-Valkema	1918	No	Yes	Yes	Yes	No	Fossils, stratigr Human fossils
Schierbeek-Valkema	1922	No	No(?)	Yes	Yes	Mendel/ De Vries	Fossils, stratigr
Schierbeek-Valkema	1930	No	Yes	Yes	Yes	-	-

Figure 4.1.1 – school book analysis material Onderwijsmuseum

4.2 – Religious signature

In the Netherlands authors of school books have always been very free to choose the subjects that they would like to discuss in their methods. This due to the 'freedom of education' law passed in 1917. Schools would choose methods that fit their philosophy and teachers or professors were asked specifically to write schoolbooks for schools matching their personal philosophy of life. Catholic authors would write the textbooks for Catholic schools, Protestant for reformed schools and there were also books without a religious signature. It is important to know the intended audience, in this case the schools of the indented pillar (see chapter 1.1) in Dutch society, before analyzing the content of the books. Therefore the first box in figure 4.1.1 shows the signature of the method. Often authors will make the intended audience and message clear in the preface to the book.

The prefaces of the schoolbooks by the protestant J. P. de Gaay Fortman and different co-authors for zoology and natural history do not declare an intended religious message for the books. We will see that contrary to the methods of de Gaay Fortman this is the case for the Catholic schoolbooks used in this research. It may be concluded that this was because the books by de Gaay Fortman were not only intended for protestant schools but for the neutral schools as well. Whereas Catholic methods were often written especially for Catholic schools so that the use of protestant or free methods were unnecessary in the classroom. According to Maartje Brattinga (2009) the methods by de Gaay Fortman were indeed intended for many different levels of education and also for different schooltypes; the HBS, gymnasium, lycea and kweekscholen (de Gaay Fortman and Heidinga, 1936. (Deel 1) titlepage). The content of the books by de Gaay Fortman do show a religious signature and also a very interesting change in the main author's attitude towards evolution that will be discussed later. Another important clue that the books have a protestant signature is the fact that one of the cited works is the book 'Creatie en Evolutie' (*Creation and Evolution*) by Dr. J. Lever (Lever, 1956). This is a protestant work in which Jan Lever discusses his ideas about theistic evolution, a popular idea within a certain branch of Dutch Calvinism. It may be assumed that a non-protestant would (in this timeperiod) not quote this very well-known protestant work (personal communication Lodewijk Palm). The confessional mark is present but it is not explicitly stated in the preface of these books.

For Catholic schoolbooks this is different, one Catholic author in the research is J.J.L. Smeets. In the prefaces to and throughout his natural history, zoology and biology books the religious intention is very clear. In the first print of his natural history book (part one, the human being) he writes:

> Door het bezit. Eener onsterfelijker ziel behoort de mensch tot een meer verhevene, hoogere orde in Gods schoone schepping dan de dieren en planten. Credo in carnis resurrectionem et vitam aeternam! Daarom is de mensch niet ingedeeld bij de dierkunde, maar is datgene, wat van het menschelijk lichaam is behandeld, in een afzonderliijk deeltje opgenomen, dat ik hierbij in de welwillendheid mijner geachte collega's aanbeveel.
>
> (By possession of an eternal soul human beings belong to a sublime higher order in Gods beautiful creation than animals and plants. Credo in carnis resurrectionem et vitam aeternam! This is why the human being is not classified within zoology but the parts of the human body that are treated are included in a separate volume that I hereby benevolently recommend to my colleagues. (Smeets, 1935. titlepage)

This preface is actually a slimmed down version of the sermon that preceded the zoology volume in his natural history method of 1926 (Smeets, 1926). Here he complains that other schoolbooks don't sufficiently point to the efficiency in nature and eliminate the all-knowing creator. He also points to the fact that most major natural historians in history were religious Christians. Here he adduces 'Linné' (Carl Lineaus) who stated that he didn't intend to look for God but eventually couldn't deny his presence in all of nature. He also opens the book with a poem about God (Smeets, 1926. p 1). Not only this but on page nine he starts of the chapter on mammals with a Dutch poem by Bernard ter Haar called 'Aan een Baviaan' (To a Baboon). The nineteenth century professor of theology wrote this poem to express his feelings about the descent of man and relatedness to primates. As Maartje Brattinga justly remarks in her 2009 thesis this is a rather peculiar choice because Smeets does not discuss the theory of evolution in his methods but he does include this poem about evolution. This would surely have confused the students and given rise to discussion in class. What is also interesting to note that in his title choice for his natural history method de Gaay Fortman (1936) decided to use the exact same title that Smeets (1926) used for this Catholic method; 'Beknopt leerboek der natuurlijke historie' (brief textbook of natural history) and both dedicate a separate volume one to the human being (Smeets, 1935). It is unknown whether this is a coincidence or an attempt by de Gaay Fortman to rewrite the by that time maybe well known and widely used Catholic schoolbook with a protestant signature and he used the literal title of the Catholic work on purpose.

Not only the natural history methods by Smeets contain a clear religious message. In the preface to his 1951 biology method published by the Catholic publisher Malmberg he writes:

> Het lichaam is het meesterstuk der schepping. Hier heeft God Zijn wondere werken van vernuft, doelmatigheid en orde opeengehoopt.
>
> (The human body is the masterpiece of creation. In it God has accumulated his works of intelligence, efficiency and order. (Smeets, 1951. titlepage))

In the zoology schoolbooks with a Catholic signature by Hoogeveen and Peeters there is also a clear religious message. They devote a paragraph to the origin of life and discuss for example the principle generatio spontanea but end it by stating that:

> Onafwijsbaar dringt zich bij deze wetenschappelijke leerstellingen de gedachte op aan een Eerste Oorzaak van het Leven, een 'Causa Prima', een Schepper.
>
> (Undeniably with these scientific dogmas a thought of a Primary Cause for Life presents itself, a 'causa prima', a creator. (Hoogeveen, 1945. p 457))

From the methods researched it appears as though the Catholic schoolbooks have a more present religious signature. They refer literally to god much more often than the protestant authors. But noted here should be that this is a very small sample of books with both religious signatures.

4.3 - Human Evolution

Human evolution remained a problem until far into the twentieth century (Brattinga, 2006), and it still is one of the main problems today. The idea that humans were related to primates was horrifying to many people. This is already apparent in the natural history method by Smeets (1926) where in the poem 'Aan een Baviaan' the poet's loathing towards a common descent shared with other primates becomes clear. In schoolbooks humans are dealt with in different ways. Some do treat humans as a species of animal. In most however humans are seen as separate from animals, especially when evolution is concerned. Some authors even invent a new topic on the school curriculum called: '*menskunde'* (anthropology) to set it apart from *dierkunde* (zoology). Brattinga concludes that the order in which the topics are dealt with is important as well. Humans, she concludes, are often discussed before all of the animals putting them in a special higher position (Brattinga, 2006. p 90).

The development in human evolution in the methods by J. P. de Gaay Fortman is very interesting because it shows the authors own changes in belief about evolution and the teaching of evolution. In figure 4.1.1 it can be seen that especially in his latest work he felt that almost all of the important aspects of the theory of evolution deserved a place in education and thus it was important to discuss them in his schoolbooks. In his 1936 method for the subject natural history he does discusses 'fossil humans' and he starts with the 'races' Neanderthal and Cro-magnon. So in effect he hints towards human microevolution but he does not specifically name it. He also discusses the much more ape-like Homo *primigenius* and the fact that it is seen by some scientists as a different human species. He states however that he thinks that whether or not this is true still remains to be seen (de Gaay Fortman, 1936. p 88-89). The reason he refers to the two (Neanderthal and Cro-magnon) as human races and not ape species is because there was evidence for cultural habits like burying their dead and therefore a belief in an afterlife. Also the usage of fire he sees as proof for humanity. Many other authors as we will see later in this paragraph use things like religion, science, history, speech, consciousness, tools and other signs of culture to set humans apart from animals and especially from primates. In (among others) his 1937 method for natural history he sums up the similarities and differences between ape and man. He concludes that there are many physical similarities and the only real difference is not physical but mental, it lies in the mental capabilities of mankind (de Gaay Fortman, 1937. p 9-11). In the eleventh edition of this book published in 1951 this part still looks pretty much the same (de Gaay Fortman, 1951. p 12-13). What is remarkable is that there is a new addition to the paragraph in which he discusses the differences between humans and apes, it's about animal psychology. De Gaay Fortman states that it might have been the physical similarities that had lead biologists like the 'well known and very skilled' Charles Darwin astray to think that the behavior, feelings and thoughts of humans also resembled that of animals. It might be that here he responds to the content of Darwin's book 'The descent of man, and selection in relation to sex', published in 1871. In this book Darwin discusses 'evolutionary psychology'. Without a reference he then states that 'the new animal psychology' has realized this mistake and now strives to free itself from it and admit that

there is a fundamental difference between the animal and human psyche (de Gaay Fortman, 1951. p 13). It remains unknown on what basis he makes this claim, but it would not be uncommon for an author of schoolbooks to infuse schoolbooks with personal ideas and convictions. It's not a scientific work that needs any references, it's a schoolbook and just like a teacher's personal beliefs will influence the student so will the opinion of the author of the schoolbook used in the classroom. In the Netherlands this is not uncommon due to the freedom of education law that is still in place today. In the twelfth edition of this natural history schoolbook, published in 1959, there is still a separate volume dedicated to the human being alone. Where the fossil human races and arguably species were first discussed in volume two (vertebrates) of the method, now there is an added chapter in the human volume about fossil humans. In this chapter de Gaay Fortman starts by discussing the traits that separates humans from animals, these are still roughly the same as in the previous editions on vertebrate animals. Again he discusses the presumed fossil human species (like the findings by the Dutch anthropologist and geologist Eugene Dubois in 1891) with care and makes the same statement that the validity of these human species still remains to be seen. He also discusses the human 'races' Neanderthal and Cro-magnon again and says nothing about their potential to be possible separate species he compares them instead to the 'racial diversity' we see today (de Gaay Fortman, 1959. p 102-104).

In his 1974 method for General Biology de Gaay Fortman has added a paragraph on evolution (de Gaay Fortman, 1974. p 32). He discusses humans at the very end of the paragraph, he states differences between fossil humans and modern humans like the fact that the fossil humans did not appear to have walked on two legs all the time. Yet he doesn't speak of real speciation or common descent with primates. In the fifth edition that appears five years later (1979) an entire chapter has been dedicated to evolution. The chapter on evolution is preceded by another enumeration of the traits that set humans apart from animals. And in the chapter about evolution he does not specifically address human evolution. Also in the paragraph on paleontology, fossil humans that had been present in the 1974 method are missing.

Apart from natural history and biology schoolbooks de Gaay Fortman has also written several zoology textbooks. In his 1951 method for zoology he again starts with the observation that humans and animals are physically very similar but he concludes by stating that mentally humans are very different from animals. He states that among all mental and cultural differences religion is the highest expression of spirituality (de Gaay Fortman, 1951. p 18). He also discusses the fossil human races but not human evolution specifically. In the third edition published in 1955 and the fifth edition published in 1960 this hasn't changed much (de Gaay Fortman, 1955) (de Gaay Fortman, 1960). In the 1969 edition (ninth edition), part 1b humans, he starts off by stating again that human beings occupy the highest place in all of nature because of their special abilities that set them apart from animals. It seems however that his view on human evolution and speciation has changed. Before he would only talk of other races of humans that had gone extinct like the Neanderthal and Cro-Magnon now he discusses the Pithecanthropus erectus (the fossil find by Dubois) as a 'humanlike fossil'. Before he noted that the ape-human descent theory was highly disputable now he says:

> In de naam aapmens ligt opgesloten, dat men deze wezens als voorlopers van de mens beschouwt. Aan deze opvatting liggen bepaalde gedachten omtrent de afstamming en evolutie van de mens ten grondslag.

> The name apeman entails a certain clue that these creatures are seen as predecessors of human beings. These ideas are based on thoughts about the descent and evolution of mankind (de Gaay Fortman, 1969. p 128).

Now he does not specifically stop to note that this is still a very disputable hypothesis. He does however at the end of the chapter conclude that there is no valid reason to suppose that Australopithecinen (Australopithicus, an early human form) is also part of the human family tree (de Gaay Fortman, 1969. p 133).

Other methods that deal with human evolution are for example the 1915 zoology method by Otto Schmeil. In his earlier zoology book (1899) human evolution isn't present yet (Schmeil, 1899) but in this edition he discusses ape like humans and also the fossil finds by Eugene Dubois. He notes that these fossils finds look as though they were much closer related to modern humans than the closest now living man-apes (Schmeil, 1915. p 25). He then notes that the common idea that the theory of evolution holds that humans are descended from monkeys is false.

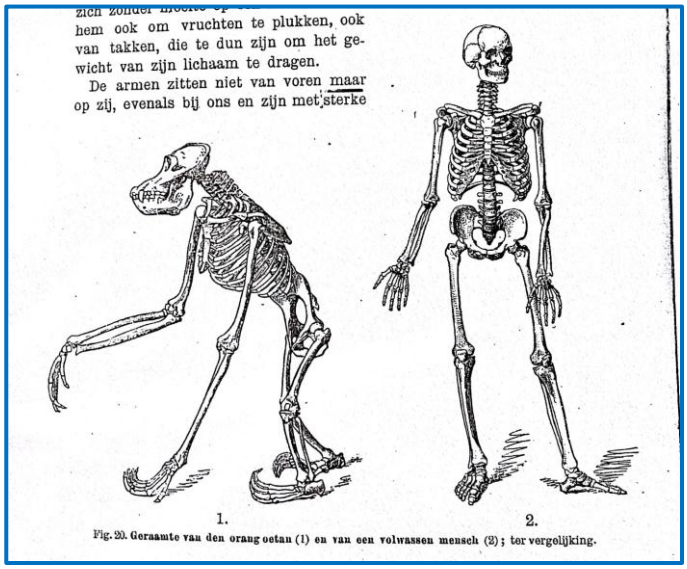
hem ook om vruchten te plukken, ook van takken, die te dun zijn om het gewicht van zijn lichaam te dragen.
De armen zitten niet van voren maar op zij, evenals bij ons en zijn met sterke
1. 2.
Fig. 20. Geraamte van den orang oetan (1) en van een volwassen mensch (2); ter vergelijking.

Image 4.0.1 Human and ape from: Schmeil, 1915 p 18

He does not discuss the possibility of a common ancestry, instead he states that the matter on human origins is far from resolved (Schmeil, 1915. p 25). In his 1936 biology method G. A. van Schaik calls the descent of human beings from another form of primate a 'reasonable assumption' (van Schaik, 1936. p 235). In a 1952 biology method P. van Biezen also discusses human evolution. He discusses the theory of evolution in with great conviction of its correctness and he also gives detailed descriptions of Darwinism, Lamarckism, Catastrophism (Cuvier) and Mutationism (de Vries). In the paragraph on transitional forms (p 199) he states that the transitional forms between the main departments of the animal kingdom as well as a transitional form between man and animal has not yet been found. He discusses the fossil finds of Eugene Dubois but notes that these fossils turned out to be apes, not human (van Biezen, 1952. p 200). So even though he is very specific about evolution he also regards the issue of human descent as unresolved. Another author who discusses human evolution is Kreutzer (1968), he is more specific about human descent and states:

> Alle gegevens van de biologie wijzen erop, dat ook de mens in het kader van de evolutie is ontstaan.
>
> All biological data suggest that also humans beings originated from the process of evolution (Kreutzer, 1968. p 363).

He goes on by describing the history of the descent of man by means of image 4.3.1. Another interesting thing about humans in the different school methods is where and when they are discussed. Some books discuss the different animals in a sequence that reminds of Aristotle's 'Great Chain of Being'. They start of by describing single celled organisms and eventually end with the most complicated and 'highest' or animals, humans. Other authors start with humans and descent down to the 'lower' animals (eg. Hoogeveen, 1919; Rombouts, 1875). In some cases a separate volume is dedicated to humans to set them apart from animals (eg. Hoogeveen, 1945; Smeets, 1935). Van Pesch (1913) starts by describing humans first and then climbs up from single celled organisms to more complicated forms ending with primates (van Pesch, 1913).

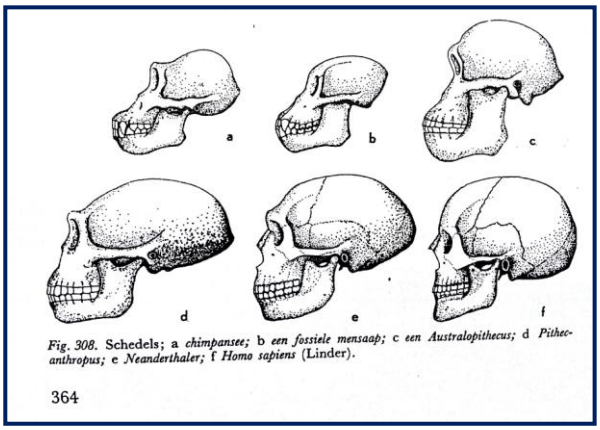

Fig. 308. Schedels; a *chimpansee;* b *een fossiele mensaap;* c *een Australopithecus;* d *Pithecanthropus;* e *Neanderthaler;* f *Homo sapiens* (Linder).

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Image 4.3.1. Kreutzer, 1968. p 364

4.4 - Micro and Macro Evolution

In the first half of the twentieth century many methods discussed the emergence of new species in the course of evolution. However they remain vague about how new species emerge from other species (Brattinga, 2006). Microevolution (variation within one species) has always been less of a problem than macroevolution (speciation by evolution). This is because variety we see all around us in breeding livestock and pets but also in the humans around us. But the idea that this variety may eventually lead to the emergence of completely new and separate species proves challenging to most people.

In the paragraph on human evolution we have seen how De Gaay Fortman deals with this in humans. For a long time he refers to what we now know to be different species as different races of man, like the Neanderthal. In later editions he comes back to this and hints towards a new conviction about speciation and thus macroevolution. This is interesting because as discussed in the paragraph on religious signature, the books by de Gaay Fortman have a protestant signature. But some protestant movements aims to reconcile science and religion, the acceptance of microevolution fits in this philosophy. The Catholic Church has accepted that microevolution exists, it is therefore not surprising that in the schoolbooks of Catholic signature microevolution is discussed. In the first edition of Hoogeveen and Peeters zoology method microevolution is present; they discuss for example the descent of our modern house cat from the Egyptian Nubian cat (Hoogeveen, 1919. p 48). In the preface of his 1926 method for Natural history the other author with a Catholic signature in this research J.J.L. Smeets discusses microevolution specifically and also denounces macroevolution:

> Dat de dieren zijn "aangepast" aan hun omgeving, d.w.z. dat organen en lichaamsbouw wonderlijke geschiktheid vertoonen om te kunnen leven, 'tzij in de lucht, in 'n boom, in 't water of in den grond en zich daar in stand te houden – dit is eenvoudig een feit. Dit wil echter niet zeggen, dat elk dier, juist zooals het nu is, is voortgekomen uit de hand des scheppers. Want dat dieren en planten zich wijzigen onder invloed van 't milieu (klimaat,

> temperatuur, vochtigheid, hoeveelheid licht enz.) is evenzeer ’n feit. De natuur in haar geheel schikt zich naar de omstandigheden, binnen zekere grenzen. Dit is echter in ’t geheel niet in strijd met de leiding van den Schepper.

> The fact that animals are "adapted" to their environment, i.e. that organs and physique show a wonderful fitness for survival, be it in the air, in a tree, in the water or on the ground and are able to sustain themselves - this is simply a fact. This does not mean that every animal in its current form originated from the hand of the creator. Because that animals and plants change under the influence of their environment (climate, temperature, humidity, amount of light, etc.) is also a fact. Nature as a whole adapts to the circumstances, within certain limits. However, this is not contradictory to the guidance of the Creator (Smeets, 1926. preface).

Methods that are very explicit about evolution are the zoology and natural history methods by Schierbeek and Valkema. They discuss embryology, heredity (Gregor Mendel) mutation (Hugo de Vries) and recapitulation (Ernst Haeckel) (e.g. Schierbeek and Valkema, 1922. p 319-333). The authors don’t name it specifically in this early method yet but from the text their conviction of the existence of macroevolution becomes clear, for example:

> Met de evolutiegedachte hangt samen een poging om te geraken tot een kennis van den stamboom van het dierenrijk.

> The idea of evolution is related to an attempt to arrive at knowledge of the family tree of the animal kingdom (Schierbeek and Valkema, 1922. p 333).

If you look at the family tree of the animal kingdom as presented by Schierbeek and Valkema (1922) their support of the idea of macroevolution becomes clear when they state that it is evolution that is related to knowing about this entire tree (image 4.4.1).

Image 4.4.1. – Schierbeek en Valkema, 1918. P 324

A very early method that has been used in this research in which macroevolution is discussed is the natural history method by C. Arenors (1880). It is well known that these ideas were around before Darwin but it is interesting to find them in a school method. He first discusses 'microevolution':

> Het blijkt ondertussen bij nauwkeurig onderzoek dat de dieren die tot dezelfde soort moeten gerekend worden, nog in menig opzicht kunnen verschilen vooral zoo zij in verschillende landstreken voorkomen en onder veschillende omstandigheden leven; de onderling afwijkende voorwerpen eener soort maken dan verscheidenheden, of, zoo de eigenaardigheden blijkbaar erfelijk zijn, verschillende rassen uit.
>
> Meanwhile after careful research it appears that these animals are to be included in the same species, yet in many respects they can vary especially when they occur in different areas under different conditions of life; the differing objects of a species result in varieties, or, if the peculiarities are hereditary, different breeds. (Arenors, 1880)

He discusses variety and different breeds, microevolution. Immediately after he discusses the topic of microevolution in his book he uses this as a stepping tile towards macroevolution:

> Uit de eene soort kan zich in den loop der tijden, langzamerhand eene andere vormen, terwijl de oorspronkelijke vervalt.
>
> In the course of time one species can gradually change in to another while the original perishes. (Arenors, 1880)

In his 1875 zoology method Rombouts doesn't explicitly use the term microevolution, he does characterize the different human races and calls this variety (Rombouts, 1875. p 50)

A later method that is also explicit about macroevolution is the 1915 zoology method by Otto Schmeil. In the preface Schmeil says:

> De oervogel was een mutant van een reptiel en is daarom niet uitgestorven.
>
> (The primitive bird was a mutated reptile and is therefore not extinct. (Schmeil, 1915. Preface by Buekers))

This can be interpreted as a positive attitude towards macroevolution because he states a species changed into a completely different species. What is strange about this comment is that he also states that therefore it has not gone extinct. He acknowledges that by means of mutation species can transform but what to make of the second part of the sentence? Maybe he aims to say that the primitive reptile did not technically go extinct because it evolved into another species and thus lives on.

In van Schaik's 1936 Biology method he states on page 235 that in order for a living being to exist there needs to be another living being. However he later also states that there is no other option than to also accept that the first life originated from lifeless matter (Schaik, 1936). So he implicitly states that large evolutionary transitions must somehow exist in order for more complex life forms to come into existence, macroevolution.

The author Van Biezen (1952) is also very clear about macroevolution in his biology method, it exists. He discusses horse evolution on page 199 and talks about the new species and genera that arose through time. He also discusses transitional forms as proof for the gradual 'microevolutionary' cause for macroevolution. He does note that transitional forms between human beings and other animals have not yet been discovered as is discussed in paragraph 4.3 on human evolution.

Kreutzer (1968)'s view on macroevolution is aberrant from the other views discussed above. He seems to be in favor of macroevolution but invokes a principle he calls 'macromutations'. As he explains it himself:

> Vele biologen nemen dan ook aan dat er behalve de 'gewone' mutaties ook z.g. macromutaties plaats grijpen: plotselinge veranderingen in bouwplan waardoor bijv. De nakomelingen van een oogloos dier ineens ogen kregen.
>
> (Many biologists therefore assume that besides the 'normal' mutations also something called macromutations take place: sudden changes in body plan which cause e.g. the offspring of an eye-less animal to suddenly have eyes. (Kreutzer, 1968. p 362))

As Depew (2009) stated this view was used in the late nineteenth mutation theory (De Vries) contesting Darwin's gradualism (Depew, 2009. p 326). Apparently Kreutzer picked this up and subsequently used it in his biology method.

4.5. - The Odd Case of Genetics

De Vries or Darwin?

Another strange part of the story of evolution in education is what I will here call 'the Odd Case of Genetics'. If you would ask a biologist he or she would tell you that genetics and evolution are inextricably connected to each other. But genetics in schoolbooks, it appears, has never presented the same challenge that evolution has. In several methods the mutation theory by Hugo de Vries is discussed together with Darwin's theory of evolution (Schierbeek en Valkema 1922. Schmeil, 1915. Van Biezen, 1952. Kreutzer, 1968 and De Gaay Fortman, 1979). In his preface to his editorship of Otto Schmeil's (1915) zoology method the Dutch author Beukers explains how the mutation theory decided that function is a consequence of shape and not the other way around. Subsequently he says that now Darwin and Weissmanns dogma 'everything is adaptation' frees us of the obligation to explain all bodily features. De Gaay Fortman (1979) discusses the theory of mutation in terms of Neo-Darwinism. The theory by Hugo de Vries has enriched and completed the theory of evolution according to this author, this is the prevailing opinion still. Also Schierbeek en Valkema (e.g. 1922) and van Biezen (1952) discuss the mutation theory as an important new component of the theory of evolution.

However often in modern as well as old school methods it would appear as is genetics (mutation) seems less of a problematic topic than the theory of evolution itself (the modern Malmberg biology methods with a Catholic signature are an example of this). Genetics is discussed openly and very extensively where evolution is sometimes moved to the background where it should in fact have a central position in the chapter. Why this special, seemingly less problematic, position for genetics? The answer may lie in the fact that the mutation theory by Hugo de Vries does not imply macroevolution, it is basically about microevolution. Microevolution has historically never been as big of a problem as macroevolution, or speciation. People, religious and non religious, can easily accept variation within species when they look at our own domesticated animals. Macroevolution, the emergence of new species, however is a different matter. This may be the reason why Mendel and de Vries' theory of heredity and mutation are less problematic than Darwin's all encompassing theory of evolution which states that selection will eventually also lead from microevolution to macroevolution. De Vries has also suggested that for macroevolution macromutations are required, the author Kreuzer discusses these in his 1968 biology method (Kreuzer, 1968. p 362). The fact that De Vries suggested this however can easily be ignored and the focus in school methods can remain on the microevolution component of his theory. Besides the problematic macroevolution the element 'survival of the fittest' in Darwin's theory can also be left out in teaching genetics. This is a concept that also has historically caused some revolt because it is considered antisocial (social Darwinism). A last important element in Darwin's theory of evolution is randomness. This too, for religious and non religious people, is a concept hard to grasp and accept. Especially religious people will not accept arbitrariness because it denies design and purpose in life. Dutch statesman and theologian Abraham Kuyper (1837 – 1920) in many of his lectures opposed Darwin's principle of 'selection' by proposing 'election' by a divine being instead (Molendijk, 2006. p 14). This also worked with De Vries' theory because the reason for mutation was not specified so it might as well be election as Kuyper puts it. Darwin insists on randomness as an important foundational principle of Evolution in nature. The case of genetics in education is an odd situation because in reality, genetics can never be seen as separate from evolution and vice versa. The fact that we still see this apparent division in modern schoolbooks is probably a remnant from the past.

4.6 - Paleontology

Looking at whether or not an author discusses paleontology is also very relevant for the analysis of their attitude towards evolution. Deep time, or geologic time, is an essential component within the theory of evolution without it the theory would definitely break down. Paleontology is also very important because it deals with fossils. Fossils are essential pieces of evidence for evolution because they show extinct forms as well as transitional forms. Paleontology is more likely to show up in methods designed for natural history but it is also discussed in biology and zoology methods. The summary in figure 4.1.1 shows that many of the school methods used in this research actually discuss paleontology, with the exception of the method with a Catholic signature by Smeets (Smeets, 1926; Smeets, 1935; Smeets 1951) The Catholic zoology method by Hoogeveen published does discuss fossils (Hoogeveen, 1945. p 99). The methods with a protestant signature all discuss paleontology (de Gaay Fortman, 1936; de Gaay Fortman, 1937; de Gaay Fortman 1951; de Gaay Fortman 1951(2); de Gaay Fortman, 1954; de Gaay Fortman, 1955; de Gaay Fortman, 1960; de Gaay Fortman, 1969; de Gaay Fortman 1974, de Gaay Fortman 1979). Noted here of course should be that all methods that

are clearly from a protestant signature all share J. P. De Gaay Fortman as their main author, so this is not very significant. And neither is the Catholic sample with only two distinctive main authors. In order to do a qualitative comparison I have looked at different components of paleontology that are important within the theory of evolution; fossils, human fossils, age of the earth and stratigraphy.

To start out again with the methods by J. P. de Gaay Fortman who discusses paleontological topics from the first schoolbook that was sampled for this research onwards. In his 1937 natural history method he discusses dinosaurs in the context of present day reptiles, he notes that there we more species of reptiles that have now long gone extinct. In his 1974 biology method he dedicates an entire chapter to 'The history of life on earth' and includes fossilization, fossils, evolution and geographic distribution of animals on earth (de Gaay Fortman, 1974). He explains that the in earlier days people used to think that the earth was only several thousands of years and that now science has shown that the earth has to be at least 4-4.5 billions of years old (de Gaay Fortman, 1974. p 28). He continues with a paragraph on fossils and fossilization and an overview of the stratigraphic time-periods. He discusses what major groups of animals arose during what time period and he now also discusses the dinosaurs in this context. He also discusses human fossils of Neanderthals (de Gaay Fortman, 1974. p 34). In the fifth edition published in 1979 the same chapter has been renamed 'Evolution, heredity and the matter of the origin of life' (de Gaay Fortman, 1979. p 9). This also reflects the growing enthusiasm of de Gaay Fortman for evolution as discussed before. Paleontology is still a part of the chapter as is fossilization, distribution. The stratigraphy timeline is still present and now it also contains the rise of several main groups of animals inside the column.

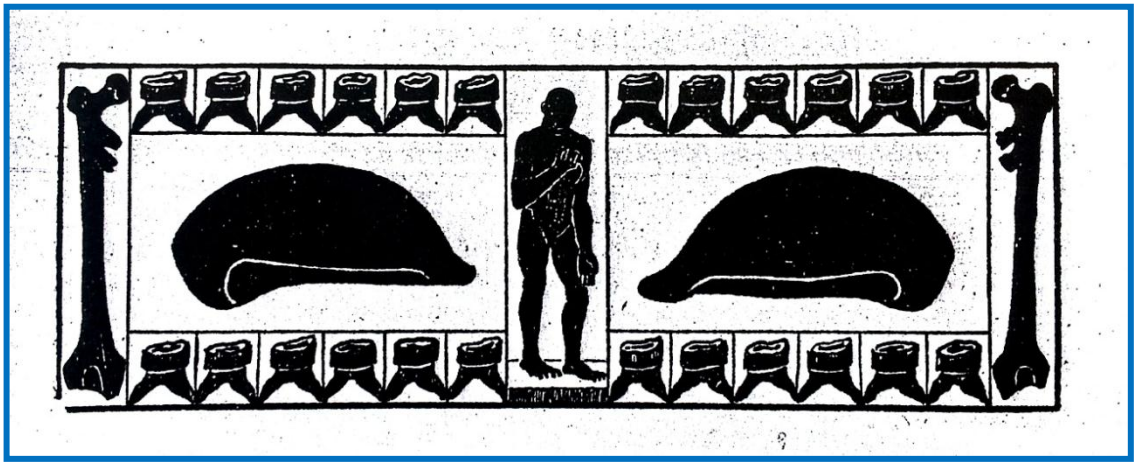


Image 4.6.1 - Dubois fossil findings from Java, skullcap, femur and molar in logo (Schierbeek en Valkema, 1918)

The authors Schierbeek and Valkema also discuss paleontology in their zoology and natural history methods (Schierbeek en Valkema, 1918, 1922, 1930). From the oldest method in this research onwards these authors pay a lot of attention to all aspects of paleontology. They elaborately explain what fossils are and how they form (Schierbeek en Valkema, 1918. p 59). Above the introduction to the chapter on paleontology they place a self-designed logo comprised of images of Eugéne Dubois' (1858 – 1940) fossils findings on the Indonesian island of Java in 1891 (image 4.6.1). Also in their 1918 zoology and natural history method they move from fossils to the topic of stratigraphy (p 61) and on page 62 they add a detailed overview of the time periods and their stratigraphic formations (Schierbeek en Valkema, 1918). In the 1922 zoology method the rise of different animal groups is

discussed in a figure that shows the different time periods (Schierbeek en Valkema, 1922. p 318). In the 1930 zoology method among other things the java-man findings of Dubois are discussed in more detail in the chapter called 'Familie 1. Menschen (Hominidae)' (Family 1. Humans (Hominidae)) (Schierbeek en Valkema, 1930. p 106).

Another author that discusses paleontology is for example C. Arenors. Already in his 1880 method for natural history he discusses stratigraphy (time periods) and the fossils found within these different layers. He also discusses many other geological topics, like different types of rock and soil and rock formation (Arenors, 1880. p 73-84). P. R. Bos discusses stratigraphy in combination with evolution even though he doesn't name evolution specifically in that chapter:

Men doet dat naar hunne ligging ten opzichte van elkander en vooral naar den aard der organische overblijfselen, die zij bevatten (*aardlagen). Want in planten- en dierenwereld heeft men een vasten ontwikkelingsgang kunnen opsporen.

One does this by means of their positioning in respect to each other and the nature of the organic remains that they hold (*earth layers). Because in the plant and animal kingdom one has discovered an ongoing process of development (Bos, 1910. p 314)

He discusses a geological principle that is called 'biostratigraphic dating', this is a way of relatively dating rock or sediment layers by their fossil content. This is extremely relevant for evolution. In his 1921 geography method Bos also discusses stratigraphy. In his 1899 edition O. Schmeil does not yet discuss paleontology. In his 1915 zoology method he does pay attention to paleontology as he states in his preface. He discusses fossils and also pays attention to extinct primates in the chapter on the order 'apes' (Schmeil, 1915. p 25). O. Thome describes in his 1928 zoology method how fossils indicate gradual changes in species (Thome, 1928. p 201). He dedicates an entire appendix (Appendix 1) to paleontology and also discusses stratigraphy and links the time periods to occurrences of different main groups of animals. He puts the 'domination' of warm blooded animals like human beings in the most recent period, the 'Alluvium'. The author H. Kreutzer also discusses stratigraphy and paleontology; he does so in a paragraph on the origin of species (Kreutzer, 1968. p 358-362). He also pays attention to the evolution and 'prehistory' of human beings (p. 363-366). Also van P. Biezen dedicates a paragraph in the chapter on evolution and descent on paleontology (Van Biezen, 1952. p 198)

4.7 - Foreign Influences

On the topic of evolution in schools the German influence on our country is especially large. We can conclude this because many early Dutch schoolbooks discussing evolution are by origin German schoolbooks edited for Dutch schools (Thome, 1889. Thome, 1915. Schmeil, 1899. Schmeil, 1915). Especially the German biologist Ernst Haeckel had a large influence on the general attitude towards evolution in the Netherlands. He was a great proponent of popularization of science. He saw science outreach to the public as an important task that scientists had (Van der Heide, 2002). He was also a proponent of international exchange of knowledge. This can be concluded from the large amount of his own work that he send to the Netherlands (Van der Heide, 2002. p 112). His ideas were sometimes

also a source of controversy. But his popularity can also be deduced from the many Dutch schoolbooks that make note of his ideas. In their 1922 Schierbeek and Valkema (p 320) make note of the recapitulation theory (1872). In this method they present evolution as a progressive process and this is illustrated by Haeckels recapitulation theory. Van Biezen also discusses comparative anatomy and Haeckel in his 1952 method.

Chapter 5 – Politics and Examination during the past 30 years

The Dutch biological council (Biologische Raad) that has existed since 1923 and became part of the Royal Netherlands Academy of Arts and Sciences (KNAW) in 1959. The KNAW already asked the government and educational committees to pay attention to the theory of evolution in 1931. Biology was then limited to the first two years of the 'gymnasium' level of education in the Netherlands (Janssen and Voogt, - p 1). The biological council asked for biology to be extended to also the fifth and sixth year because:

> ".. De geest der leerlingen reeds openstaat voor de behandeling van een aantal algemeene biologische vraagstukken op het gebied der afstemming, der ontwikkeling en erfelijkheid…"
>
> ".. The students minds are already opened to the treatment of a few general biological questions concerning descent, development and heredity.."

According to Cornelis van Mierlo, who wrote a dissertation about biology education from a developmental-psychological and pedagogical viewpoint at the university of Groningen, especially during the past 30 year there has been an organized and contemplating way of thinking about biology education (Mierlo, 2004. Chapter 9).

5.1 - Institutions and Education Laws

The Dutch school system knows a national testing for the different High School levels. This so called Central Final Examination (CSE) has been in place since 1976 (Kees Koopman, 1995. p 1). Biology was among the subjects on the first CSE in 1976 (Mierlo, 2004. Chapter 9). Apart from the central national examination there is also the local examination (SE) conducted by the schools themselves (see 5.2). The final word on the content of both the CSE and also the SE comes from the Ministry of Education, Culture and Science (OC&W). They accept or reject a recommendation from a specially appointed committee. When the terms this committee suggested appear in the 'state gazette' (staatscourant) it means that the content is now state-law and mandatory material for a subject's testing and teaching. Many other institutions and committees have a say in the development of this recommendation and also on whether or not the Ministry should choose to accept it. Some of these institutions are the CITO, College voor Examens and the Onderwijsraad. Important for evolution is the program for biology (other subjects that may also discuss evolution like ANW and NLT not to be discussed here). In 1983 the committee for the reviewing of biology exam programs (Werkgroep herziening Examenprogramma's Biologie, WEB) drafted their first brochure advising that every biology topic should be tested on the Dutch biology exams. When they came out with their official advice in 1994

(Mierlo, 2004) (Appendix I) (Earlier unofficial advices were already used by the ministry or this date is incorrect) the onderwijsraad (board of education) however advised the minister not to include certain topics, including evolution, in the CSE but to refer it to the SE (Koopman, 1995). Since the schools are free to make their own SE material this meant that evolution took a backseat in class. Cornelis van Mierlo is also of opinion that the advice from the WEB committee hasn't been done much justice, not only on the topic of evolution (Mierlo, 2004. Chapter 9). From this time onwards we see a grave haggling of the topic of evolution in the Dutch examinations. When a new system called '2e fase' was implemented in Dutch High Schools the exam program was reviewed again. This time evolution was included in the central examination but I would like to argue that this was 'incognito' in paragraph 5.3. In 2004 the latest committee, the CVBO, was installed by secretary Maria van der Hoeven and was led by Kerst Boersma. This committee recognized the problem and they made absolutely sure that evolution is now very explicitly described in the terms on the exam program (terms F, see appendix F). They also insisted on the point that at least some of the F-terms should be included in the national central examination. It was decided that these would be term F1 and F2 because more specific questions could be asked about these elements of term F (evolution). This was decided in consultation mainly with the CITO, which is the organization responsible for the development of Dutch exams. It had to do with the testability of the subjects not with any objections considering the personal and or religious convictions of students (personal communication Kerst Boersma and Leen van den Oever, CVBO committee).

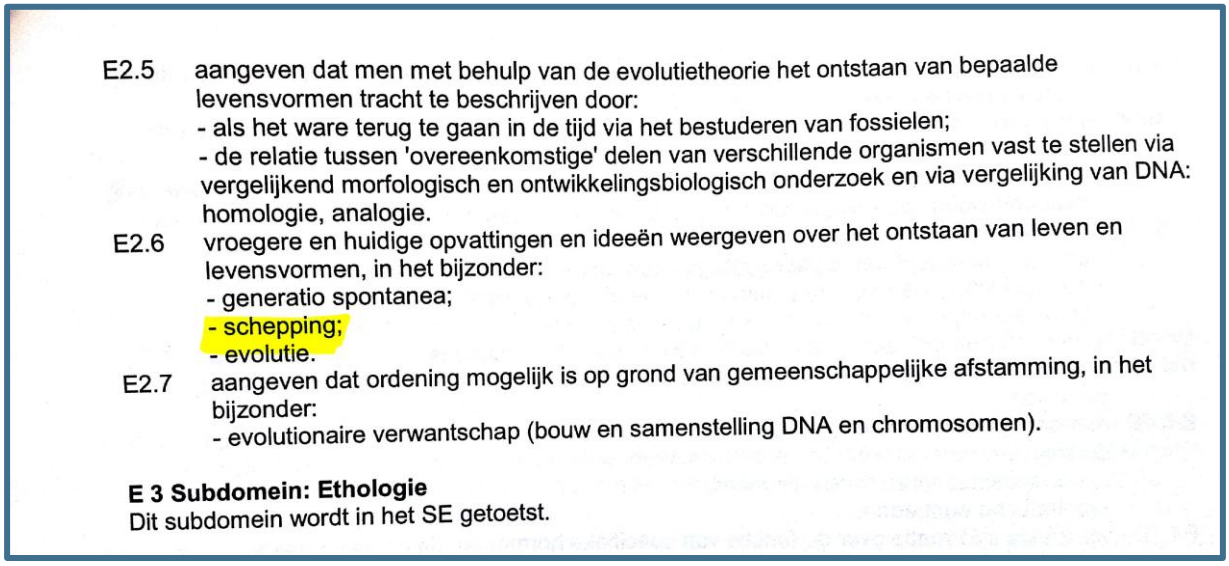
5.2 - Local and Central Examination

As stated in paragraph 5.1 the Dutch examinations are split into two parts, one is to be developed and conducted at the schools themselves and consists of multiple exams throughout the final two years. This is called the 'schoolexamen', school exam or SE and is a local examination varying per school. It is also bound however by the terms that are issued by the government. In the subject syllabus, that is issued once every few years, there is a table telling the schools what subjects are to be tested on the local and what subjects will be tested on the central examination (Appendix D and E). When the MAVO level exam program was announced in 1988 the theory of evolution was added to the terms but it was specifically excluded from the national central examination (CSE). When the program for HAVO (1991) and for VWO (1993) was announced here too evolution was to be excluded from the national central examination. In both cases evolution was directed to the local examination and as stated before schools are relatively free in the design of these local exams (SE's). This was achieved by excluding term 67 (Appendix I) from the national central examination (Kees Bos, 1995. p 2). (In appendix I only the overview of subdomains of the WEB advice is included, term 67 is part of subdomain 13).

Term 67 says:

> " De kandidaat kan toelichten dat mutaties en selectie kunnen leiden tot het ontstaan van nieuwe rassen en soorten in de loop van de tijd"
>
> " The candidate can explain how mutations and selection can lead to the emergence of new races and species over time"

The national press took note and a nationwide discussion erupted over the issue. In the evolution-special by *Bionieuws* in 1995 this discussion is well recorded. Some articles that were issued in the national press suggested that evolution was taken out of the exam program altogether. The former Secretary Ginjaar-Maas pointed out that before evolution was not part of the exam program at all, it had not been removed it had only been selected for the local instead of the central examination (Bionieuws, 1995). When the exam program was reviewed again during the implementation of the new Dutch educational system called '2e fase' in 1998-99, evolution was added to the central examination part of the exam program (Boersma, 2007). But it was a very minor addition, also the word evolution was now flanked by the terms 'generatio spontanea' and 'creation' (image 5.2.1).



E2.5 aangeven dat men met behulp van de evolutietheorie het ontstaan van bepaalde levensvormen tracht te beschrijven door:
- als het ware terug te gaan in de tijd via het bestuderen van fossielen;
- de relatie tussen 'overeenkomstige' delen van verschillende organismen vast te stellen via vergelijkend morfologisch en ontwikkelingsbiologisch onderzoek en via vergelijking van DNA: homologie, analogie.

E2.6 vroegere en huidige opvattingen en ideeën weergeven over het ontstaan van leven en levensvormen, in het bijzonder:
- generatio spontanea;
- schepping;
- evolutie.

E2.7 aangeven dat ordening mogelijk is op grond van gemeenschappelijke afstamming, in het bijzonder:
- evolutionaire verwantschap (bouw en samenstelling DNA en chromosomen).

E 3 Subdomein: Ethologie
Dit subdomein wordt in het SE getoetst.

Image 5.2.1 – Scan from Biology exam program VWO after the '2e fase' modification, 'creation' is highlighted.

5.3 - Terminology in the exam programs

This strange position and context of the word evolution was also a source of resistance from many Dutch biology teachers. It strongly hinted towards the 'equal time principle' used by the ID proponents in the United States. The Dutch Institute for Biology (NIBI) asked 200 visitors of the annual education convention what they thought of the idea that creation now had a place in the exam program for biology (35 % respondents). Biology teachers said they had trouble with the now obligatory treatment of creation besides evolution. Ten percent indicated that they never named 'the alternatives', 25% names it occasionally and 65% always name it in class (van Caulil, 2005). The exam program with this formulation of the terms is currently still in use and it will be replaced with the new terms established by the CVBO in 2012-2013. However it won't be until the implementation of the new syllabi for biology on the HAVO and VWO level in 2015 (HAVO) and 2016 (VWO) that the students and teachers will actually start using the new terms.

From the late 80's (WEB) onwards evolution has become an item on the nationally regulated biology program. The trend seems to be that it became more present and more important, as was the wish of many of the biology teachers and Dutch biologists in general. This is especially true for the latest renewal of the biology program by the CVBO. However it's very apparent that it has been a troubling item, this becomes clear when we look for example at the quarreling over the testing of evolution on

the national central examination or the local school in paragraph 5.2. But it can also be deduced from the delicate and evasive terminology that is used to describe the evolutionary terms on the exam program and also the positioning of the word itself. In this paragraph I would like to highlight a couple of these 'evasions' by comparing the old exam terms (WEB including the additions for the 2e fase) and the most recent CVBO exam terms.

For this comparison I will look at only the VWO level program because the wording and content on this particular subject is not that different from the HAVO level program.

As discussed before in the previous terms (WEB) the F-term 'evolution' (CVBO) is still absent, but this does not mean that the topic evolution is not actually in the terms. Term C1 for example reads 'heredity':

> **Subdomein C1: Erfelijkheid**
>
> De kandidaat kan erfelijkheid op organismeniveau verklaren door het beschrijven van erfelijkheidsprocessen op lagere organisatieniveaus en kan het ingrijpen door de mens in erfelijkheidsprocessen bediscussiëren. (appendix G)
>
> **Sundomain C1: Heredity**
>
> The candidate can explain heredity at the level of the organism by describing genetic processes at lower organizational levels and is able to discuss human intervention on hereditary processes.

It is interesting to note here that it specifically says 'can explain heredity at the level of the organism'. It would seem as though this makes it possible to avoid using heredity in exam questions on a larger scale or longer timescale – evolution. This also reminds of the fact that in schoolbooks it seemed a lot less problematic to discuss genetics or heredity as such, as long as it wasn't expanded to include speciation or evolution in general.

But evolution is definitely present in these exam terms even before the actual term was surreptitiously added (image 5.2.1) during the '2e-fase' review. It is present in term E2. Term E2 states:

> **Subdomein E2: Ontstaan en handhaving van verscheidenheid**
>
> De kandidaat kan de betekenis van verscheidenheid in een populatie, onder andere op gen niveau, aangeven, en opvattingen weergeven over het ontstaan daarvan.
>
> **Subdomain E2: Origin and maintenance of diversity**
>
> The candidate can describe the significance of diversity in a population, eg. at gene level, and can state beliefs about its origin.

‘Origin and maintenance of diversity’ is in fact a marvelously long and devious way of just saying ‘evolution’. (Appendix H) is added to show that the term E2 is also continuously seized by many designers of biology exams to ask questions very specifically about evolution.

In the exam questions themselves words like evolution; natural selection and images of eg. evolutionary trees are not shunned at all. This is an interesting fact because as stated before the slight riot that occurred after the implementation of these current terms was about the absence of evolution from the central examination. Evolution isn’t absent, it’s just cleverly hidden in the exam terms under term E2. And in the current terms it’s also stated specifically that term E2 should be tested on the CSE, central examination:

Het centraal examen

Het centraal examen heeft betrekking op de subdomeinen B1, C1, D1, D3, D4, D5, E2, E4 en E5, in combinatie met de vaardigheden uit domein A. De CEVO kan bepalen, dat het centraal examen ten dele betrekking heeft op andere subdomeinen, mits de subdomeinen van het centraal examen tezamen dezelfde studielast hebben als de in de vorige zin genoemde. De CEVO stelt het aantal en de tijdsduur van de zittingen van het centraal examen vast. De CEVO maakt indien nodig een specificatie bekend van de examenstof van het centraal examen.

Het schoolexamen

Het schoolexamen heeft betrekking op domein A en de domeinen en subdomeinen waarop het centraal examen geen betrekking heeft; indien het bevoegd gezag daarvoor kiest: een of meer domeinen of subdomeinen waarop het centraal examen betrekking heeft; indien het bevoegd gezag daarvoor kiest: andere vakonderdelen, die per kandidaat kunnen verschillen.

The central examination

The central examination refers to the sub-domains B1, C1, D1, D3, D4, D5, E2, E4 and E5, in combination with the skills of domain A. The CEVO may determine that the national examination in part relates to other subdomains, provided that the subdomains of the main exam cover the same amount of time. The CEVO determines the number and duration of the sessions of the central examination. The CEVO, if necessary, announce a specification of the content of the national examination.

the school exam (local examination)

The school exam covers domain A and all domains and subdomains not covered the central examination. If the authorized authority so chooses: one or more domains or subdomains not covered in the central examination and also other topics may be added.

What is interesting about this passage is that it only states that terms not tested on the CSE (central examination) may be added to the SE (local examination) if an authorized authority (the Ministry) chooses to do so. However based on the literature research in newspapers the topic of evolution was moved, by the Secretary (an authorized authority), from the CSE to the SE. According to the 'rules' laid down in this document (Appendix G) that should not be possible. I have not been able to figure out whether this was the cause for the riot (the Secretary doing something that could not actually be done) ór whether they weren't actually talking about term E2.

So even though the actual term evolution was added in 1998-1999 (2e-fase addition) the topic of evolution has been present on Dutch exams since the late 80's (or more likely since the early 90's because it takes a few years for new terms to seep through to the actual exams). So with the new CVBO terms that will officially be taken in use during the school year 2013-2014 and will take probably 2 to 3 years more to trickle down through the system of syllabi and actual exams what is added in terms of evolution? It will not be the first time evolution appears on the Dutch central examination as it would seem at first if one only takes a look at the history of government controlled exam terms in Biology. However, it is the first time that evolution is added to the terms specifically and elaborately. Including terms like natural selection, DNA, mutation, recombination and variation:

Domein F: Evolutie

Subdomein F1: Selectie

De kandidaat kan met behulp van de concepten DNA, mutatie, recombinatie en variatie ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze variatie in populaties tot stand komt.

Subdomein F2: Soortvorming

De kandidaat kan met behulp van de concepten populatie, variatie, selectie en soortvorming ten minste in contexten op het gebied van gezondheid en wereldbeeld verklaren op welke wijze nieuwe soorten kunnen ontstaan.

Subdomein F3: Biodiversiteit

De kandidaat kan met behulp van het concept biodiversiteit ten minste in contexten op het gebied van duurzaamheid benoemen op welke wijze de diversiteit van populaties en ecosystemen binnen het systeem Aarde varieert.

Domain F: Evolution

Subdomain F1: Selection

The candidate can use the concepts of DNA, mutation, recombination and variation minimally in the context of health and food production and explain how variation in populations is established.

Subdomain F2: Speciation

The candidate can use the concepts of population, variation, selection and speciation minimally in context in the field of health and worldview and explain how new species arise.

Subdomain F3: Biodiversity

Using the concept of biodiversity the candidate can name the manner in which the diversity of populations and ecosystems varies minimally in context of durability.

Underlined in the Dutch terms is the part ‘tenminste in contexten’, this translates to ‘minimally in context’. This part is used in the description of all 3 terms. I have asked Dr. Kerst Boersma, a member of the CVBO committee, about this and he states that this formulation was added in a late stadium of completion of the new terms. The change is based on a request by, if I understood correctly CITO, and has only got to do with the room and direction this formulation gives to designing exam questions. It has got nothing to do with soothing the formulation of the term.

The question whether evolution has been tested on the Dutch national exams or not and since when turns out to be hard to answer. And like a lot of things concerning evolution and education it appeared not to be straight forward at all. In the case of the state rules for exams and the exams themselves this has to do with on the one hand the many different committees and institutions concerning themselves with its content and on the other hand the obvious sensitivity of the subject.

Discussion

Was evolution ever and is evolution still an issue in the Netherlands and what seems to be the main issue? I would like to argue that is was and that it still is, and that it is religion that is the main issue. It took a little while for the theory of evolution to make it into the Dutch schoolbooks, but that is the case for every new scientific theory. From the wording that some authors use when they do discuss it in the early methods it can be concluded that some had their reservations towards the theory and that they regarded some parts of it as controversial or even untrue. This may have been the reason that many authors chose not to incorporate the theory into their methods in at first or at all.

Religion is definitely an important component in the discussion, some religious groups obviously had and still have more trouble with the theory of evolution than others. It would seem as though the tables have turned for two important religious groups in the Netherlands. Some groups within the Protestant church at first appeared to have a more open attitude towards evolution, and some groups within this church had a more open attitude towards science in general. The schoolbooks investigated that were written by the (one) Protestant author show an open attitude towards evolution. The Catholic authors almost never discussed evolution in their early schoolbooks and referred to God literally much more often. It is not possible to refer to Protestant church as a whole because this group is extremely diverse, the Catholic group is much more coherent. In contrast to the way it seemed to be earlier, today it looks as though it is now the Protestant, especially the Dutch reformed, schools that have more trouble with evolution. In these Dutch 'bible belt' schools creation is often taught alongside the obligatory subject of evolution, equal time has much support here. And it looks as though it's the Catholic schools that now aren't too difficult about the subject nor about equal time.

I think it is safe to say that in many of the arguments over the theory of evolution in schools even today, religious motives still play a role of some sort. It may not be out of personal conviction, it is possible that politicians aim to take into account the religious views of some of the Dutch people because they feel like they have a duty to. The following has not really been discussed in this thesis because the Catholics and the Protestant church are 'native' to the Netherlands. But another religious group that apparently has large issues with evolution is the growing Islamic population of the Netherlands. Especially in biomedical academic studies it is an often heard problem that students from the Muslim religion do not accept the theory of evolution. This discussion was kept out of this thesis deliberately because it is a whole different discussion altogether and also a relatively recent development. Overall religion arguably seems to be the biggest issue when it comes to evolution and whether or not it should be taught in school. Only in the beginning doubts about the validity of the theory itself by the authors of the books played a role. In the US it is also religion that is the most important factor in the discussion.

Is the discussion in the Netherlands comparable to the one in the United States? The fact that an American movement like intelligent design gained a foothold in Dutch politics doesn't necessarily say something about evolution and how it is taught in Dutch schools but it does mean that there is also support for the principle of equal time in the Netherlands. It could be argued that this makes sense because in in the Netherlands, just like in the United States, there is a large support for religious freedom. In the US this stems from the fact that many immigrants had a different background and it was even recorded in the first amendment of the American bill of rights that religion should not be

imposed in public places. In the Netherlands I would like to argue that this similar feeling stems from the previous pillarization of the Dutch society. The Dutch people fought for the rights to have their own pillar in society and when the pillarized system collapsed there may have risen a joint feeling of mutual religious respect and tolerance (similar to the sentiment amongst the early immigrants to the US). Also it may have been for self-protection after the safety of the pillars was gone. This may be a reason why intelligent design landed well in the Dutch society. It never gained the proportions that it did in the US however, where numerous lawsuits were filed. This is would also be made impossible in the Netherlands by the law of freedom of education.

The discussion therefore is comparable and yet it is not. In the US the sheer size of the issue makes it very different from the discussion in the Netherlands. Also religious and political aspects are more obviously connected in the US discussion. In the Netherlands politics play a role in for example evolution in education, but whenever specific religious comments are brought up this is preferably kept out of politics. In the US religion is politics, especially on the topic of evolution. Another large difference is caused by the fundamentally different laws that apply to the issue in both countries. In the US it would seem as though the law inhibits religious arguments from entering the public school system and the Dutch law basically encourages this. However unexpected, the reality is that the issue is more problematic and the tone of the discussion is much more fierce in the US. But Overall this thesis may also show that there are more similarities between the Netherlands and the United States on the topic of evolution and education then would be expected at first.

What happened to the advice by the WEB committee? A difficult matter when doing research for this thesis was finding out what the advices of (especially the former) committees for renewal of biology education were and what had subsequently been done by the Dutch governmental departments to implement them. It can be traced what the content of the advice was and what was eventually implemented in the biology exam programs. But why some things were added or removed or moved to the local examinations can only be guessed. Here also I would like to argue that the most likely reason was protection of the life philosophy of a part of the Dutch population. Someone (undisclosed for privacy reasons) I have spoken even hinted towards personal convictions of some of the members of the Dutch Department of Education culture and science at the time. This of course would be pretty unseemly but absolutely not unheard of at all. And therefor I will also regard this as a possibility. Unfortunately I cannot back this up with any real evidence. Off the most recent committee, the CVBO, I have spoken with two members (Leen van den Oever and Kerst Boersma) who have both assured me that there was no such censorship whatsoever this time and that the modifications concerning the topic of evolution were purely made on request of the CITO for exam question technical reasons.

Problems

During this thesis some aspects proved to be problematic, two of them will be discussed here shortly. As stated in the introduction deducing things from old school methods can be tricky. This because it is unknown how the teachers used these methods. The same still goes for school methods today only now that we have the exam programs and the teachers are obliged to treat certain topics. But even then there is no obligation to use a particular school method, it only says students need to learn about these topics and be prepared for the central examination level. For the old schoolbooks the problem is slightly bigger, all that can eventually be said is that evolution is present in some form or another in some of the books but it was up to the teachers to also treat this part of the book. And if even the authors of the schoolbooks had their reservations towards evolution it can probably be assumed that many of the teachers had their reservations as well.

Another problem was the confusing track of implementation of Dutch exam programs. Just about every source names a different year of for example the implementation of the WEB program or the 2e fase modification. The reason for this is that the implementation trajectory takes many years and every source chooses a different starting point. One chooses the publication date of the advice by the committee, the other the first date that an actual exam is designed according to the new guidelines. Meanwhile as much as 5 to 10 years may have passed. What is also problematic is that there appears to be no standard implementation route and the number and sort of organizations and committees that have a say in the process are not always the same. It is apparently up to the Minister what advices to take and the route of final implementation is extremely variable.

Conclusion

The aim of this thesis was to present a broad overview of the teaching of evolution in Dutch education. It was attempted to put the research on primary material (part 2) in context by first discussing the history of Dutch education, the history of the theory of evolution in the public sphere and the discussion about this topic in the United States (part 1). How the theory of evolution was received in Dutch education is hard to say. As stated, it is the public opinion on a topic that will influence the government and today the government also decides about education and the teaching- and exam-topics. But when the theory of evolution was presented by Darwin in 1859, education wasn't a governmental affair in the Netherlands yet. This started early in the 20th century and in the 1980's the exams also started to become regulated by the government. The first method to discuss evolution that was used in this research appeared in 1918 but this may not be the first Dutch schoolbook that contained evolution. The way evolution was dealt with in the schoolbooks that paid attention to it was variable. Some discussed it in great detail where others briefly named it and also noted specifically that this was a theory that they were themselves still uncertain of but felt it had to be named because of its significance in biology, zoology and natural history and some ignored it. The Dutch pillarization played a large role in Dutch education and also definitely in evolution in education. In the paragraph 'religious signature' it becomes clear that it was very important what the background of an author was for the way evolution was presented and if it was discussed at all. Noted should be that not to many strictly confessional schoolbooks were researched but two different authors can be seen as Catholic and one author as Protestant. The conclusion that may be drawn

from this sample size is that it appears as though especially the Catholic methods pay a lot of attention to the 'Lord' and religion in their biology, zoology and natural history (etc) methods. They use many literal references, poems and prefaces stating the religious foundation of the books. This principle affects evolution in the way that it appears to be almost completely absent in the Catholic methods. The one Protestant author that was used for the research however seems to go through a transition when it comes to his view on evolution. He starts out hesitantly stating that this is a theory and he is not yet sure if it is completely accurate and he discusses his differences with the theory (his main objections are on human evolution and origins). In later versions of his (famous) schoolbooks het starts leaning more and more towards fully accepting the validity of the theory of evolution. The pillarization had its effect on the religious signatures in school methods because the religious or non-religious signature was present everywhere in the Dutch society. Religion was not the only parameter that was used to describe the varying reception of the theory of evolution in Dutch schoolbooks in this research, human evolution is also important as a sort of proxy for the degree of acceptance of the theory of evolution.

Human evolution has always been a problematic part of Darwin's theory and remains so until today. The official most recent statement by the Catholic church on the matter is currently that "there is no conflict between evolution and the doctrine of the faith" but the idea that any theory of evolution that provides a materialistic explanation for the human soul is rejected (Pope John Paul the 2nd, 1996) (Message delivered to the Pontifical Academy of Sciences on 22 October 1996). Even one of the Catholic methods, that doesn't even really deal with evolution, mocks the idea of human evolution by means of a poem. One way to deal with human evolution that can be observed in the methods that do discuss evolution is by placing humans in a separate chapter, especially many of the zoology methods do this. They discuss the animals in a sort of order from high to low or low to high and usually place humans in a separate chapter above the highest animal class as to set them apart from animal evolution. Some authors add a separate volume to the zoology method dedicated to humans and even a new school subject 'anthropology' was in some schools added to the curriculum besides 'zoology'. An often heard reason for setting humans apart from animals is that humans poses consciousness, religion, tools etc and animals don't. Also the 'descent' (as is often misunderstood) or 'common descent' we share with primates is often problematic. Some authors downright deny that this could ever be true even though they see merit in the rest of the theory of evolution. There are however also authors that discuss human evolution as it is presented by Charles Darwin and place humans in the generic line together with the other animals. Another proxy by which the acceptance of the theory of evolution as Darwin presented it can be judged is the discussing of both micro and macro evolution.

Microevolution often isn't an issue, the Catholic church has officially accepted that microevolution occurs. Macroevolution, or speciation, however is a larger problem. Again because it conflicts with religious beliefs and also because it is one of the parts of the theory that is harder to grasp as microevolution is visible to the naked eye and macroevolution takes too much time to actually witness. In the school methods used for the research it can also be seen that the one is less problematic than the other. In every method that discusses macroevolution, microevolution is also discussed but in many of the methods only microevolution appears. An interesting feature of many school books that is closely related to the micro-macro evolution issue is genetics.

Genetics like the mutation theory by Hugo de Vries are often discussed in the schoolbooks, seemingly separate from evolution sometimes. It appears that this is based on a misunderstanding that the

mutation theory is only about microevolution. The same mutations that lead to microevolution will eventually lead to macroevolution. So the strange position of genetics seems to be based on a misunderstanding about the mutation theory by many of the schoolbook's authors. Lastly the handling of paleontology also provides an insight in the authors views on evolution.

Just as the view that humans are animals and the common descent of humans and other primates the age of the earth has also been a problematic concept for many people. This has religious as well as intellectual grounds, because it is hard to imagine an enormous timescale like the age of the earth. But if an author deals with paleontology in his method this sets an important condition for the discussion of evolution. And discussing paleontology usually also entails discussing fossils, and fossils are also vital for understanding the principle of geological time, extinction and evolution. Many authors discuss paleontology and many also do this in the light of evolution and change. Notably the Catholic methods do not deal with paleontology in any of their methods, most likely because a geologically old earth does not compute with their religious worldview. The one Protestant author discusses paleontology from the very beginning, even when he was still skeptical about some parts of the theory of evolution.

Another aim of this thesis was to compare the discussion, the history and the situation in the Netherlands with that of the United States. In the US the issue has been much more present in the public sphere compared to the Netherlands. Legally the current situations for both countries are very different. The US are bound by the first amendment that basically states that religion may have no prominent place in public institutions like education. It is ironic that this law was put in place long ago so that members of the different religious groups would not come into conflict with each other and now it is used to keep things like Intelligent Design out of the classrooms by atheist movements. This was not something that the founding fathers, who were all religious, could have ever foreseen. In the Netherlands on the other hand we have a law called 'freedom of education' that enables schools to have their own (religious) 'color' as it were. This law was implemented much later than the first amendment of the US constitution but it strangely enough aims to achieve the same thing. The US law wanted to give its people freedom of religion by not imposing one religion. And the Dutch government attempted to give its people freedom of religion by allowing them to have their 'own schools' as was customary in the Dutch pillarized system. The expectation would be that in the Dutch system the teaching of evolution would be more problematic because there is no actual law preventing religion from having a prominent place in the classroom. The contrary is true, the problem is much bigger in the United States. One reason for this is because religion plays a more prominent role in everyday life in the US and state laws are binding as long as they do not interfere with federal laws. This is the reason that in the US many court cases have been fought out over evolution in classrooms. Historically the Dutch reformed immigrants have played an important role in the US religious lobby, also in the evolution in school debate. So this can be viewed as an early influence of the Netherlands on the US. The return influence of the US on the Netherlands is noticeable today when things that were 'invented' in the US like: creation science, intelligent design and stealth creationism blow over to the Netherlands. The reason that these 'American ideas' could sometimes easily take root in an entirely different society can be found in the Dutch neo-Calvinists who uphold strong international bonds. Intelligent design took root in the Netherlands the best, it even has a few strong advocates even in Dutch politics.

The current discussion about evolution in Dutch education is still ongoing. Today the content for the national exams in the different school subject containing evolution is determined by the state but this

does not mean that the discussion is over. The determination of the exam programs is a collaboration between many different institutions and the sensitivity of the subject in religious aspect also plays a role in politics still. This research concludes that evolution has actually been part of the exam program since the late 80's (this is not the message in many of the mostly popular scientific articles about this topic). But it can be said that it was absolutely described incognito, for example as 'the origin and maintenance of diversity'. This may be the reason why many authors state that evolution first appeared in the Dutch exam program in the late 90's. During the late 90's when the 2e fase was implemented the actual term 'evolution' was indeed added to the exam program for the first time and it was added together with the terms 'generatio spontanea' and 'creation'. Only in the new program just recently released by the CVBO evolution has a separate term and all the other evolution buzzwords are added and creation is dropped. This program is currently yet to be implemented. It can thus be concluded that evolution is definitely still an issue in Dutch education today and it could be argued that with the new CVBO program the hassle may finally cease. But with the Dutch freedom of education law still in place schools are still free to teach basically whatever they like besides the now compulsory topic of evolution.

References

Secondary sources

BLANCKE, S. 2010. Creationism in the Netherlands. *Zygon Journal.* Vol. 45, no 4. 791-816.

BOEKHOLT, P. Th. F. M. BOOY, E. P. 1987. Geschiedenis van de School in Nederland, vanaf de middeleeuwen tot aan de huidige tijd. Van Gorcum, Assen/Maastricht.

BOERSMA, K. T., GERAEDTS, C. L., HULLU DE, E., JANSSEN, F., JONGE, C. 2007. Evolutie in het voorgezet onderwijs. Nederlandse Vereniging voor het Onderwijs in de Natuurwetenschappen (NVON) Groningen.

BORENSTEIN, J. 2008. Textbook stickers: A Reasonable Response to Evolution? *Science & Education.* 17:999-1010.

BRATTINGA, M. 2006. 'Zouden onze voorouders er zo uitgezien hebben?' Hoe de evolutietheorie ontvangen werd in Nederlandse familiebladen en schoolboekjes 1867-1974. Masterthesis at the University of Amsterdam (UVA).

DEPEW, D. J. 2009. Darwinian Controversies: An Historiographical Recounting. *Science & Education* 19:323-366 (2010)

ELDREDGE, N., GRENE, M. 1992. Interactions. Columbia University Press, New York. (in Depew, 2009)

FLIPSE, A. C. 2012. The Origins of Creationism in the Netherlands: The Evolution Debate among Twentieth-Century Dutch Neo-Calvinists. *Church History* 81:1, 104-147.

GERAEDTS, C. L., BOERSMA, K. T. 2000. Ontwikkeling van het begrip natuurlijke selectie in havo-vwo. Tijdschrift voor Didactiek der B-wetenschappen. 17, nr 2.

GILLIS, A. M. 1994. Keeping creationism out of the classroom. Grassroots efforts and the Constitution hold their own against religious extremism. *BioScience.* Vol 44 No. 10.

JANSSEN, F., VOOGT, P. (-). Evolutietheorie in het Voortgezet Onderwijs. Vakgroep Didactiek van de Biologie, Universiteit Utrecht.

KOOPMAN, K. (different authors). 1995. BIONIEUWS, Evolutiespecial. Nieuwsmedium voor Biowetenschappen & - Technologie. 23 september 1995, jaargang 5. (from: Bionieuws archives, Utrecht)

LE BEAU, B. F. 2007. Science and Religion: A Historical Perspective on the Conflict over Teaching Evolution in the Schools. *Radical History Review.* Issue 99.

LEUNE, J. M. G. 2002. Onderwijs en maatschappelijke verandering. Een terugblik op 200 jaar onderwijs en onderwijsbeleid in Nederland. In *Tweehonderd jaar onderwijs en de zorg van de Staat* Boekholt, P. Van Crombrugge, H. Dodde, N. L. and Tyssens, J. Van Gorcum Assen. (yearbook)

LEVER, J. (1956). Creatie en Evolutie. Zomer en Keunings, Wageningen.

MIERLO VAN, C. 2004. Existentieel biologieonderwijs: Een heroriëntatie op het biologieonderwijs vanuit een pedagogisch en ontwikkelings-psychologisch perspectief. Dissertation at the University of Groningen (RUG).

MILLER, J. D., SCOTT, E. C., OKAMOTO, S. 2006. Public acceptance of evolution. *Science* 313, 765-766.

MOLENDIJK, A. L. 2006. Neocalvinistische cultuurprotestansisme. Abraham Kuypers stone lecture. *Dokumentatieblad voor de Nederlandse Kerkgeschiedenis na 1800.* 29/65, 5-1.

NCSE. 2008. What is 'Intelligent Design' Creationism? *www.ncse.com.*

NCSE. 2010. A new Gallup poll on evolution. *www.ncse.com.*

NOORDUYN, J. 1846. de Verzameling van wetten betrekkelijk het Lager Onderwijs in Zuid Holland, Gorinchem (book, not accessed)

PETROVSKI, P. 2009 'Evolutie of Schepping, wat geloof jij?' *www.godvoordommen.nl* (internet text)

SALZBERG, S. L. 2008. Creationism Slips Into a Peer-Reviewed Journal. *Reports of the National Center for Science Education*. Volume 28, Issue 3 p 12-14, 19.

SCHMEIL, O. 1899. Leerboek der Dierkunde. (Eerste Deel Weveldieren?). Voor Nederland bewerkt door: P.G. Buekers. 2nd edition. W. J. Thieme & Cie, Zuthpen.

SCHMEIL, O. 1915. Leerboek der Dierkunde. Eerste Deel Weveldieren. Voor Nederland bewerkt door: P.G. Buekers. 6th edition. W. J. Thieme & Cie, Zuthpen.

SMITH, M. U., SIEGEL, H., McINERNEY, J. D. 1995. Foundational Issues in Evolution Education. *Science & Education.* 4, 23-46.

SMOCOVITIS, V. B. 2000. The 1959 Darwin centennial celebration. In: Abir-Am P, Elliott C (eds) Commemorative Practices in Science. Special issue of Osiris, second series, vol 14, pp 274-323 (not seen)

THOME, O. W. 1889. Leerboek der Dierkunde. Berwerkt door N. Van de Wall en herzien door J. C. Costhbus. 3rd edition. H.L.A. Campagne en Zoon, Tiel.

THOME, O. W. 1915. Leerboek der dierkunde. Deel 1, Het Menselijk Lichaam. Bewerkt door J. J. Prins. 3rd edition. Noordhof, Groningen.

VAN CAULIL, G. 2005. 'Mens ga dan naar je bijbelclub!' (interview Bert Bakker, D66). *Bionieuws.* Editie 15.

VAN CAULIL, G. 2005. Helft docenten behandeld schepping met tegenzin. Bionieuws, editie 11.

VAN DER HEIDE. J. 2002. Haeckel in Holland. Nederlandse correspondentie aan een Duits Darwinist en monist. Gewina 25, 99-112.

VAN HORN, G., JOHNSTON, L. 2006. Evolutionary Controversy and a Side of Pasta: The Flying Spaghetti Monster and the Subversive Function of Religious Parody. University of Florida. *Golem Journal.*

VAN MIERLO, C. 2004. Een heroriëntatie op het biologieonderwijs vanuit pedagogisch en ontwikkelings-psychologisch perspectief. Proefschrift, Hoofdstuk 9. Een chronologie van het denken in Nederland over de inhoud van het biologieonderwijs. Rijksuniversiteit Groningen.

VAN 'T HOOG, A. 2005. Ministerie stimuleert debat Intelligent Design. *Bionieuws.* Edition 8.

WARDA, M, HAN, J. 2008. Mitochondria, the missing link between body and soul: Proteomic prospective evidence. In: Proteomics DOI: 10.1002.

YOUNG, D. A. 2009. The reception of geology in the Dutch Reformed tradition: the case of Herman Bavinck (1854-1921). *Geology and Religion: A History of Harmony and Hostility.* M. Kolbl-Ebert (London: Geological Society, 2009). 289-300.

ZAMMITO, J. 2002. Kant, Herder and the birth of anthropology. University of Chicago Press, Chicago.

ZIMMER, C. 2010. Evolution and the Media. *Evolution and education Outreach.* 3:236-240. Springer Science+Business Media.

Primary sources

ARENORS, C. (edited by: Burgersdijk, L. A. J., Costeur, D. J., Winkler, T. C.). 1880. Schoolatlas voor de beoefening der natuurlijke historie. Sijthoff, Leiden. 4th edition.

DE GAAY FORTMAN, J. P., HEIDINGA, H. 1936. Beknopt leerboek der natuurlijke historie. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 1: De mens. Wolters, Groningen. 4th edition.

DE GAAY FORTMAN, J. P., HEIDINGA, H. 1937. Beknopt leerboek de natuurlijke historie. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 2: Gewervelde Dieren. Wolters, Groningen. 5th edition.

DE GAAY FORTMAN, J. P., HEIDINGA, H. 1951. Beknopt leerboek de natuurlijke historie. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 2: Gewervelde Dieren. Wolters, Groningen. 11th edition.

DE GAAY FORTMAN, J. P., HEIDINGA, H. 1959. Beknopt leerboek de natuurlijke historie. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 1: De Mens. Wolters, Groningen. 12th edition.

DE GAAY FORTMAN, J. P., HEIDINGA, H., VAN DER MAAS, C. J. J., MYLANUS, H. J. 1974. Algemene biologie. Voor de onderbouw van gymnasia, athenea en havoscholen, voor mavoscholen en pedagogische akademies. Wolters-Noordhoff, Groningen. (edition unknown).

DE GAAY FORTMAN, J. P., HEIDINGA, H., VAN DER MAAS, C. J. J., MYLANUS, H. J. 1979. Algemene biologie. Voor de onderbouw van gymnasia, athenea en havoscholen, voor mavoscholen en pedagogische akademies. Wolters-Noordhof, Groningen. 5th edition.

DE GAAY FORTMAN, J. P., HEIDINGA, H., VAN DER MAAS, C. J. J. 1951 (2). Leerboek der Dierkunde. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 2: Gewervelden Dieren. J. B. Wolters, Groningen, Djakarta.

DE GAAY FORTMAN, J. P., HEIDINGA, H., VAN DER MAAS, C. J. J. 1955. Leerboek der Dierkunde. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 2: Gewervelden Dieren. 2nd Edition. J. B. Wolters, Groningen.

DE GAAY FORTMAN, J. P., HEIDINGA, H., VAN DER MAAS, C. J. J. 1960. Leerboek der Dierkunde. Voor Gymnasia, Hogere Burgerscholen, Lycea en Kweekscholen. Deel 2: Gewervelden Dieren. J. B. 5th Edition. Wolters, Groningen.

DE GAAY FORTMAN, J. P., HEIDINGA, H., VAN DER MAAS, C. J. J. 1951. Leerboek der Dierkunde. Voor VWO en HAVO. Deel 1B: De Mens. 9th Edition. Wolters, Groningen.

HOOGEVEEN, E. J. V. M., PEETERS, L. 1919. Leerboek der dierkunde. Ten dienste van hoogere burgerscholen en gymnasia, normaal-, kweek- en M.U.L.O.- scholen. L. C. G. Malmberg , Nijmegen. 1st edition.

HOOGEVEEN, E. J. V. M., PEETERS, L. 1945. Leerboen der mens – en dierkunde voor het voorbereidend hoger en middelbaar onderwijs en kweekscholen. Malmberg, 's Hertogenbosch. 10th edition.

KREUTZER, H. H., VINKEN, F. A. 1968. Biologie voor de kweekschool. Wolters-Noordhoff, Groningen. 7th edition.

ROMBOUTS, J. E. 1875. Dierkunde, met aanwijzingen de gewichtigste voortbrengselen uit het Dierenrijk. Erven F. Bohn, Haarlem.

SCHIERBEEK, A., VALKEMA, D. 1918. Dierkunde. Een moderne leidraad bij het onderwijs in de Natuurlijke Historie. Op hoogere burgerscholen het 3- en 5 jr gymnasia, opleidings-inrichtingen voor A.S. onderwijzers en hoofd-onderwijzers. 1e deel. 1st edition. W. Versluys, Amsterdam.

SCHIERBEEK, A., VALKEMA, D. 1922. Dierkunde. Een moderne leidraad bij het onderwijs in de Natuurlijke Historie. 2e deel. 2n edition.

SCHIERBEEK, A., VALKEMA, D. 1930. Dierkunde. Een moderne leidraad bij het onderwijs in de Natuurlijke Historie. Op hoogere burgerscholen het 3- en 5 jr gymnasia, opleidings-inrichtingen voor A.S. onderwijzers. 1e deel. 4th edition. W. Versluys, Amsterdam.

SMEETS, J. J. L. 1926. Beknopt leerboek der natuurlijke historie voor het M.U.L.O. Deel 2: Dierkunde. Malmberg, 'S Hertogenbosch.

SMEETS, J. J. L. 1935. Beknopt leerboek der natuurlijke historie voor het voortgezet onderwijs (revised by Zwegers, B. V.). Deel 1: De mens. 5th edition. Malmberg , 'S Hertogenbosch.

SMEETS, J. J. L. 1951. Biologie van de mens. Leerboek voor het voortgezet onderwijs (revised by Zwegers, B. V.). Malmberg, 'S Hertogenbosch.

SCHMEIL, O. (edited by Beukers, P. G.) 1899. Leerboek der Dierkunde. Thieme, Zutphen. 2n edition.

SCHMEIL, O. 1915. Leerboek der Dierkunde. 1e Deel Werveldieren. Thieme, Zutphen. 6th edition.

VAN BIEZEN, P. 1952. Biologie voor de hoogste klassen van de N.N.S. Deel 2. W. Versluys, Amsterdam.

VAN PESCH, A. J. 1913. Leerboek der dierkunde. Eerste deel. Groningen. 3rd edition.

VAN PESCH, A. J. 1921. Leerboek der dierkunde. Tweede deel. Groningen. 3rd edition.

VAN SCHAIK. G. A, DUYFF, J. W. 1936. Beginselen der Biologie. Voor middelbaar en voorbereidend hoger onderwijs, voor inrichtingen ter opleiding van onderwijzers en voor eigen studie in drie delen. Deel 2, Dierkunde. W. E. J. Tjeenk Willink, Zwolle.

VAN PESCH, A. J. 1913. Leerboek der Dierkunde. 1e deel. Wolters, J. B. Groningen. 3rd edition.

Glossary

ANW – Dutch abbreviation for a High School subject called: 'Algemene Natuurwetenschappen' - general sciences.

Atheneum – Academic preparation level of Dutch High Schools. This level of High School education will grant the student entrance to the Dutch universities.

Biologische Raad – The 'Biological Council' is part of the KNAW, the Dutch Royal Academy for Science. It is sought after for advice in matters concerning Biology and Biology Education by the Dutch government. It is the oldest council in the KNAW.

CEVO – Dutch abbreviation for 'Centrale Examencommissie Vaststelling Opgaven vwo, havo, vmbo' The main focus of the CEVO was to ensure the quality of Dutch exams. The CEVO has recently (December 2011) been incorporated into the CVE* (see CVE)

CITO – Dutch abbreviation for 'Centraal Instituut voor Toetsontwikkeling'. The CITO is a developer of exams and tests.

CSE – Dutch abbreviation for 'Centraal Schriftelijk Eindexamen' – Central final examination (national).

CVBO – Dutch abbreviation for Commissie Vernieuwing Biologie Onderwijs. The Committee Renewal of Biology Education was founded by minister Maria van der Hoeven in December 2004 and was led by Dr. Kerst Boersma. Its function was to develop new examprograms for the havo and vwo parts of the Dutch secondary education.

Compartmentalization – Also known as 'pillarization' and is a Dutch phenomenon ('verzuiling') that can also be seen in other countries. It is the vertical subdivision of society not into classes but into groups or 'columns' sharing the same life philosophy. In the Netherlands we can distinguish the Catholic, the Protestant, the Liberal and the Socialist column.

CVE – Dutch abbreviation for 'College Voor Examens' is composed of the CEVO, the State Exam Committee VO and the State Exam Committee NT2 due to new legislation. The CVE is an independent administrative that is responsible for all central examinations and state examinations in Dutch secondary education.

CVBO – De commissie vernieuwing biologie onderwijs. The committee for the renewal of bioloy education.

Eindtermen – 'Final terms', a committee determines (once every x years) these terms per subject. These are the compulsory elements that are to be tested on the Dutch school and national central examinations.

Gymnasium – See 'Atheneum'. Added are the compulsory courses Greek and Latin.

HAVO - Level of Dutch High Schools that will grant the student access to the Universities of applied sciences in the Netherlands.

HBO - University of applied sciences (Hoger beroepsonderwijs).

HBS – Dutch abbreviation for ‘Hogere Burger School’, higher burgher school.

KNAW – Dutch abbreviation for ‘Koninklijke Nederlandse Akademie van Wetenschappen’ - Royal Netherlands Academy of Arts and Sciences.

Kweekschool – Dutch schooltype for primary education that no longer exists.

LBO - Dutch abbreviation for ‘Lager Beroeps Onderwijs’, lower professional education.

Lyceum – See ‘Atheneum’, added is Latin.

MAVO – Level of Dutch High School education that will grant the student access to

MBO - Dutch abbreviation for ‘Middelbaar Beroeps Onderwijs’, medium professional education.

MMS - ‘Middelbare Meisjes School’. Medium secondary girl school.

MULO – Dutch abbreviation for ‘Meer Uitgebreid Lager Onderwijs’, this is a form of lower secondary education that no longer exists.

NIBI - Dutch abbreviation for ‘Nederlands Instituut voor Biologie’, the Dutch Institute for Biology.

NLT – Dutch abbreviation for ‘Natuur, Leven en Techniek’, nature life and technology. A new schoolsubject designed to add more advanced topics of study to the school curriculum.

OC&W – Ministerie van Onderwijs, Cultuur en Wetenschap. The ministry of Education, Culture and Science.

Onderwijsraad – The ‘Educational Board’ is an independent advisory college that was founded in 1919. It advices the Dutch government on law and policy concerning public education.

Schoolstrijd – The start of the Dutch compartmentalization, the ‘conflict of education’.

Staatscourant – ‘State-gazette’. When a new law passes it is published in this gazette that is published by the Dutch state in order to inform the public of the contend of the law.

WEB – Dutch abbreviation for ‘Werkgroep herziening Examenprogramma Biologie’ the Committee for the reviewing of Biology exam Programs.

Appendices

Appendix A

Article 23 from the Dutch constitution, added in 1917
Source: www.wettenoverheid.nl
Accessed on 13-01-2012

Grondwet

Artikel 23

1. Het onderwijs is een voorwerp van de aanhoudende zorg der regering.

2. Het geven van onderwijs is vrij, behoudens het toezicht van de overheid en, voor wat bij de wet aangewezen vormen van onderwijs betreft, het onderzoek naar de bekwaamheid en de zedelijkheid van hen die onderwijs geven, een en ander bij de wet te regelen.

3. Het openbaar onderwijs wordt, met eerbiediging van ieders godsdienst of levensovertuiging, bij de wet geregeld.

4. In elke gemeente wordt van overheidswege voldoend openbaar algemeen vormend lager onderwijs gegeven in een genoegzaam aantal openbare scholen. Volgens bij de wet te stellen regels kan afwijking van deze bepaling worden toegelaten, mits tot het ontvangen van zodanig onderwijs gelegenheid wordt gegeven, al dan niet in een openbare school.

5. De eisen van deugdelijkheid, aan het geheel of ten dele uit de openbare kas te bekostigen onderwijs te stellen, worden bij de wet geregeld, met inachtneming, voor zover het bijzonder onderwijs betreft, van de vrijheid van richting.

6. Deze eisen worden voor het algemeen vormend lager onderwijs zodanig geregeld, dat de deugdelijkheid van het geheel uit de openbare kas bekostigd bijzonder onderwijs en van het openbaar onderwijs even afdoende wordt gewaarborgd. Bij die regeling wordt met name de vrijheid van het bijzonder onderwijs betreffende de keuze der leermiddelen en de aanstelling der onderwijzers geëerbiedigd.

7. Het bijzonder algemeen vormend lager onderwijs, dat aan de bij de wet te stellen voorwaarden voldoet, wordt naar dezelfde maatstaf als het openbaar onderwijs uit de openbare kas bekostigd. De wet stelt de voorwaarden vast, waarop voor het bijzonder algemeen vormend middelbaar en voorbereidend hoger onderwijs bijdragen uit de openbare kas worden verleend.

8. De regering doet jaarlijks van de staat van het onderwijs verslag aan de Staten-Generaal.

Appendix B

Text from the Dutch Law on Education from 1806
Source: Noorduyn, J en Zoon. 1846. de Verzameling van wetten betrekkelijk het Lager Onderwijs in Zuid Holland (on: remery.home)
Accessed on 13-01-2012

A. Wet voor het Lager Schoolwezen en Onderwijs in de Bataafsche Republiek 1806

Aan hun Hoog Mogende, Vertegenwoordigende het Bataafsch Gemeenebest, allen, dengenen, die deze zullen zien of hooren lezen, Salut! Doen te weten: Vooreerst: Dat door Ons Ontvangen en goedgekeurd zijnde de Voordragt van den Raadspensionaris, daartoe gedaan, dien ten gevolge is besloten te arresteren, gelijk wordt gearresteerd bij dezen de navolgende Wet voor het Lager Schoolwezen en Onderwijs, in de Bataafsche Republiek.

Art.1. Het bijzonder opzigt over den staat en de inrigting der Lagere Scholen , als mede over geheel het Lager Onderwijs, is, onder het oppertoezigt van den Raadpensionaris, of van den Secretaris van Staat voor de Binnenlandsche Zaken namens denzelven, en onder toevoorzigt van het Departementaal en Landschaps-Bestuur, alomme in dit Gemeenebest, opgedragen aan Personen, onder den naam van Schoolopzieners, welke (waar zulks vereischt wordt) dit opzigt oefenen onder medewerking van of gecombineerd met andere Personen en Commissiën of Collegiën, naar den aard der Scholen.

Art.2. De Departementale Besturen zorgen, dat alomme, zoo veel mogelijk , binnen hun Departement gelegenheid voorhanden zij, om de jeugd behoorlijk onderwijs te doen erlangen; maar dat echter door eene onbepaalde toelating van Scholen of Onderwijzers, vooral ten platten Lande, derzelver aantal niet te zeer vermeerdere.

Art.3. Wijders trachten zij, benevens de respective Gemeente-Besturen, naar de middelen in hunne handen gesteld, des noods, door het Gouvernement aan hun te bezorgen, het bestaan en het lot der Schoolonderwijzers te verbeteren en te verzekeren, als mede de betere Schoolinrigting en Onderwijs, als ook het aanleggen van Arbeid- of Industriescholen bij de Openbare Scholen en die in de Godshuizen, aan te moedigen en uitte breiden.

Art.4. De Schoolopzieners, woonachtig binnen hetzelfde Departement of Landschap Drente, maken met elkander uit de Commissie van Onderwijs voor het departement of Landschap; doch zullen in het Departement Holland twee of drie zoodanige Commissiën gevestigd worden.

Art.5. Behalve de bevoegdheid van de Departementale en het LandschapsBestuur, om in den zijne het toevoorzigt over het Schoolwezen aan te bevelen aan eene bijzondere Commissie uit hunne Vergadering, benoemen zij ieder één lid uit hun midden; dat meer bijzonder daarmee zal belast zijn en in eene meer onmiddelijke betrekking zal staan tot de respectieve Commissiën van Onderwijs en Schoolopzieners, te dien effecte , dat deze zich bij zoodanig Lid, in alle gevallen, het Schoolwezen betreffende, ter eerster instantie zullen behooren te vervoegen. In het Departement Holland zullen uit het Bestuur twee of drie zoodanige Leden benoemd worden, namelijk één voor elke der Commissiën van Onderwijs, aldaar gevestigd.

Art.6. De Raadspensionaris bepaalt de globale som, welke aan de gezamenlijke Leden van elke commissie zal worden toegelegd, en doet derzelve, benevens alle andere uitschotten en onkosten, door de onderscheidene Schoolopzieners in hunne bualiteit op last van den Secretaris van Staat voor de Binnenlandsche zaken geimendeerd, betalen uit de daartoe bestemde Post op de Begrooting der Staatsbehoeften.

Art.7. De bepallingen van het aantal der Leden van elke commissie, als ook de Districtverdeeling en distributie der globale sommen onder derzelve, zullen door den Raadspensionaris geschieden, en naar eisch van veranderende omstandigheden kunnen herzien en veranderd worden.

Art.8. De eerste aanstelling der leden van elke Commissie, als ook die der nieuwe bij eene eventueele vermeerdering van derzelve getal, zal geschieden door de Raadspensionaris.

Art.9. Omtrent de verschillende zaken, in de drie voorgaande artikelen vervat, doet de Secretaris van Staat voor de Binnenlandsche Zaken, de noodige voordragten aan den Raadspensionaris.

Art.10. Ter vervulling der in vervolg van tijd openvallende Schoolopzienersplaatsen, leveren de respective Commissieen eene Nominatie van twee personen in bij het Departementaal Bestuur, hetwelke dezelve, voorzien van zoodanige bedenkingen, als het dienstig mogt oordeelen, en voorts zulks verkiezende, vermeerder met een of twee Personen, inzendt bij den Secretaris van Staat voor den Binnenlandsche Zaken, die deze Nominatie aan den Raadspensionaris voordraagt, om daar uit een Schoolopziener te verkiezen.

Art.11. De Commissien van Onderwijs, Schoolopzieners en Zoodnige Plaatselijke Schoolcommissien, als ingevolge nadere bepalingen zullen worden gevestigd, zorgen, dat de Wetten en Reglementen, algemeene en bijzondere, omtrent het Lager-Schoolwezen en Onderwijs, binnen hunne Departementen, Districten, Steden of Plaatsen, worden nagekomen, en onder geenerlei voorwendsel krachteloos gemaakt of geeludeerd; in welk geval zij deswegens hunne klagten, naar den aard der zaken, inleveren bij het Plaatselijk, Departementaal of Nationaal Bestuur.

Art.12. Geene Lagere School zal ergens, onder welken naam ook, mogen bestaan of opgerigt worden, zonder uitdrukkelijke vergunning van het respectief Departementaal, Landschaps- of Gemeente-Bestuur, na vooraf gevraagde inlichting en bedenkingen van den Schoolopziener van het District of de plaatselijke Schoolcommissie.

Art.13. Niemand zal binnen de Bataafsche Republiek eenig LagerOnderwijs geven, dan die de vier navolgende vereischten bezit: Vooreerst: Dat hij zijn goed burgerlijk en zedelijk gedrag door één of meer voldoende Getuigschriften kan bewijzen. Ten tweede : Dat hij de Algemeene Toelating tot het geven van Onderwijs erlangd hebbe. Ten derde: Dat hij, na en boven deze Algemeene Toelating, eene Aanstelling of Admissie tot deze of gene School , of voor deze of gene Plaats, wettiglijk verkregen hebbe. Ten vierde : Dat hij zich , na liet verkrijgen eener Speciale Beroeping, Aanstelling of Admissie, met de Bewijsstukken, daartoe betrekkelijk, bij den Schoolopziener van het District of de Plaatselijke Schoolcommissie in persoon of schriftelijk vervoegd hebbe. Zijnde hieronder niet begrepen de Onderwijzers , welke in particuliere huizen inwonen, en aan kinderen, tot dat huis behoorende, onderwijs geven.

Art.14. Diegenen, welke zich, na het in werking brengen dezer Wet, zouden mogen verstouten, om, tegen het in de beide voorgaande artikelen vastgestelde aan, eene Lagere School op te rigten of Lager Onderwijs te geven, onder welken naam of op welke wijze ook, zullen voor de eerstemaal verbeuren

de somma van vijftig Guldens, voor de tweede maal honderd Guldens, te bekeeren een derde gedeelte aan den Officier, hiertoe competent, die de calange zal doen, en twee derde gedeelten ten profijt van het Plaatselijk Schoolwezen, met vrijlating aan den Regter, om, ingevalle zij onvermogend zouden mogen zijn, om gemelde boete te voldoen, aan de overtreders zoodanige andere arbritaire correctie te infligeren, als naar aanleiding van hunne personen en omstandigheden bevonden zal worden te behooren en voor de derdemaal hen de inwoning binnen de plaats worden ontzegd, voor den tijd van zes jaren.

Art.15. Van de bepalingen, in het 13de Artikel gemaakt, zijn uitgezonderd alle de thans wettig fungerende Onderwijzers , zoo lang zij niet van School of Plaats veranderen, onder reserve nogtans van nadere voorziening, in geval van blijkbaar wangedrag of verregaande onkunde.

Art.16. De Algemeene Toelating tot het geven van eenig Lager Onderwijs kan alleen verkregen worden door het afleggen van een behoorlijk Examen voor daartoe bevoegde Collegiën of Personen.

Art.17. De Speciale beroepingen,Aanstellingen en Admissien, geschieden door daartoe bevoegde Personen of Collegien in dier voege, als nader bij het Huishoudelijk Reglement ,(Art. 20 vermeld) zal worden bepaald; zoo echter, dat geene beroeping, Aanstelling of Admissie zal mogen geschieden, buiten behoorlijke voorkennis en medeweten van, en voorafgaande ‘vertooning der bewijzen van Algemeene Toelating aan den Schoolopziener van het District of de Plaatselijke Scboolcommissie.

Art.18. Alle, die, de Algemeene toelating tot het geven van Onderwijs ‘verkeegen hebbende, zich aan pligtverzuim, overtreding of weerstreving der algemeene Wet of aan blijkbaar wangedrag schuldig maken, zullen, voor de eerste maal, met de opschorsing hunner Acte van Algemeene Toelating voor den tijd van zes weken, en, voor de tweede maal, met de volkomen intrekking dier Acte worden gestraft, verliezende daarmede gelijktijdig het regt en genot hunner Speciale Beroeping, Aanstelling of Admissie, en zullende, des niettegenstaande ‘voortgaande met het geven van Onderwijs, vervallen in dezelfde boeten en straffen, als bij Art. 14 zijn vastgesteld.

Art.19. Deze opschorsing en intrekking der Acte van Algemeene Toelating zal, op voordragt der Commissie van onderwijs of der Plaatselijke Schoolcommissie, geschieden door het daartoe bevoegd Gemeente-, Departementaal- of Nationaal Bestuur, en, waar dit vereischt mogt worden, onder ruggespraak met de bjjzondere Personen of Collegien, als tot zoodanige Onderwijzers de naaste betrekking hebben.

Art.20. Alle nadere en bijzondere bepalingen omtrent alles, wat het Lager Schoolwezen en Onderwijs in de onderscheidene Departementen en het Landschap bijzonderlijk vordert, worden geregeld door een Huishoudelijk Schoolreglement, door elke Commissie respectivelijk op den voet van Art. 5 te ontwerpen, - en aantebieden aan bet Departementaal- of Landschaps-Bestuur, om door hetzelve , na voorafgaand overleg met den Secretaris van Staat voor de Binnenlansche Zaken, te worden gearresteerd.

Art.21. De Raadpensionaris stelt vast alle zoodanige nadere Reglementen, Verordeningen en Instructien, als ter geregelde en krachtdadige Invoering dezer wet in het bijzonder, enter bevordering van het Lager Schoolwezen en Onderwijs in het algemeen, dienstig en noodig zullen worden geoordeeld. En. worden hier mede alle Plakkaten, Statuten, Ordonnantien, Keuren of Reglementen, binnen deze Republiek op het Schoolwezen geemaneerd, en alle Schoolverordeningen, hoe ook genaamd, ook speciaal de Publicatie van 29 Julij 1803, benevens alle daaruit voortgesproten

algemeene en bijzondere Verordeningen en Schoolreglementen, onder welken naam ook, afgeschaft en buiten effect gesteld op zoodanig tijdstip, als, ten gevolge van het ‘volledig in ‘werking brengen dezer Wet, door den Raadpensionaris aan den Volke zal worden bekend gemaakt.

Ten tweeden: dat, uit krachte van het bepaalde bij bet 2lste Art. der vorenstaande Wet, zijn , vastgesteld, gelijk mede worden vastgesteld bij dezen, het Reglement, de Verordeningen en de instructie hierna onder A, B en C geextendeerd.

Appendix C

European Union Assembly Debate, 4 October 2007
Source: www.assembly.ceo.int
Accessed on 31-05-2012

Parliamentary **Assembly**
Assemblée parlementaire

Parliamentary Assembly
Assemblée parlementaire
COUNCIL OF EUROPE CONSEIL DE L'EUROPE

Resolution 1580 (2007)[1]

The dangers of creationism in education

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1. The aim of this resolution is not to question or to fight a belief – the right to freedom of belief does not permit that. The aim is to warn against certain tendencies to pass off a belief as science. It is necessary to separate belief from science. It is not a matter of antagonism. Science and belief must be able to coexist. It is not a matter of opposing belief and science, but it is necessary to prevent belief from opposing science.

2. For some people the Creation, as a matter of religious belief, gives a meaning to life. Nevertheless, the Parliamentary Assembly is worried about the possible ill-effects of the spread of creationist ideas within our education systems and about the consequences for our democracies. If we are not careful, creationism could become a threat to human rights, which are a key concern of the Council of Europe.

3. Creationism, born of the denial of the evolution of species through natural selection, was for a long time an almost exclusively American phenomenon. Today creationist ideas are tending to find their way into Europe and their spread is affecting quite a few Council of Europe member states.

4. The prime target of present-day creationists, most of whom are of the Christian or Muslim faith, is education. Creationists are bent on ensuring that their ideas are included in the school science syllabuses. Creationism cannot, however, lay claim to being a scientific discipline.

5. Creationists question the scientific character of certain areas of knowledge and argue that the theory of evolution is only one interpretation among others. They accuse scientists of not providing enough evidence to establish the theory of evolution as scientifically valid. On the contrary, creationists defend their own statements as scientific. None of this stands up to objective analysis.

6. We are witnessing a growth of modes of thought which challenge established knowledge about nature, evolution, our origins and our place in the universe.

7. There is a real risk of serious confusion being introduced into our children's minds between what has to do with convictions, beliefs, ideals of all sorts and what has to do with science. An "all things are equal" attitude may seem appealing and tolerant, but is in fact dangerous.

8. Creationism has many contradictory aspects. The "intelligent design" idea, which is the latest, more refined version of creationism, does not deny a certain degree of evolution. However, intelligent design, presented in a more subtle way, seeks to portray its approach as scientific, and therein lies the danger.

9. The Assembly has constantly insisted that science is of fundamental importance. Science has made possible considerable improvements in living and working conditions and is a rather significant factor in economic, technological and social development. The theory of evolution has nothing to do with divine revelation but is built on facts.

10. Creationism claims to be based on scientific rigor. In reality the methods employed by creationists are of three types: purely dogmatic assertions; distorted use of scientific quotations, sometimes illustrated with magnificent photographs; and backing from more or less well-known scientists, most of whom are not specialists in these matters. By these means creationists seek to appeal to non-specialists and spread doubt and confusion in their minds.

11. Evolution is not simply a matter of the evolution of humans and of populations. Denying it could have serious consequences for the development of our societies. Advances in medical research, aiming at combating infectious diseases such as Aids, are impossible if every principle of evolution is denied. One cannot be fully aware of the risks involved in the significant decline in biodiversity and climate change if the mechanisms of evolution are not understood.

12. Our modern world is based on a long history, of which the development of science and technology forms an important part. However, the scientific approach is still not well understood and this is liable to encourage the development of all manner of fundamentalism and extremism. The total rejection of science is definitely one of the most serious threats to human and civil rights.

13. The war on the theory of evolution and on its proponents most often originates in forms of religious extremism closely linked to extreme right-wing political movements. The creationist movements possess real political power. The fact of the matter, and this has been exposed on several occasions, is that some advocates of strict creationism are out to replace democracy by theocracy.

14. All leading representatives of the main monotheistic religions have adopted a much more moderate attitude. Pope Benedict XVI, for example, as his predecessor Pope John-Paul II, today praises the role of science in the evolution of humanity and recognizes that the theory of evolution is "more than a hypothesis".

15. The teaching of all phenomena concerning evolution as a fundamental scientific theory is therefore crucial to the future of our societies and our democracies. For that reason it must occupy a central position in the curriculums, and especially in the science syllabuses, as long as, like any other theory, it is able to stand up to thorough scientific scrutiny. Evolution is present everywhere, from medical overprescription of antibiotics that encourages the emergence of resistant bacteria to agricultural overuse of pesticides that causes insect mutations on which pesticides no longer have any effect.

16. The Council of Europe has highlighted the importance of teaching about culture and religion. In the name of freedom of expression and individual belief, creationist ideas, as any other theological position, could possibly be presented as an addition to cultural and religious education, but they cannot claim scientific respectability.

17. Science provides irreplaceable training in intellectual rigor. It seeks not to explain "why things are" but to understand how they work.

18. Investigation of the creationists' growing influence shows that the arguments between creationism and evolution go well beyond intellectual debate. If we are not careful, the values that are the very essence of the Council of Europe will be under direct threat from creationist fundamentalists. It is part of the role of the Council of Europe's parliamentarians to react before it is too late.

19. The Parliamentary Assembly therefore urges the member states, and especially their education authorities to:

19.1. Defend and promote scientific knowledge;

19.2. Strengthen the teaching of the foundations of science, its history, its epistemology and its methods alongside the teaching of objective scientific knowledge;

19.3. make science more comprehensible, more attractive and closer to the realities of the contemporary world;

19.4. Firmly oppose the teaching of creationism as a scientific discipline on an equal footing with the theory of evolution and in general the presentation of creationist ideas in any discipline other than religion;

19.5. Promote the teaching of evolution as a fundamental scientific theory in the school curriculums.

20. The Assembly welcomes the fact that 27 academies of science of Council of Europe member states signed, in June 2006, a declaration on the teaching of evolution and calls on academies of science that have not yet done so to sign the declaration.

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1. *Assembly debate* on 4 October 2007 (35th Sitting)

Appendix D

Syllabus centraal examen 2015 HAVO (p 23 – 26)
Source: www.examenblad.nl
Accessed: 10-12-2012

Domein E. Reproductie

Biologische eenheden, zoals enkele celorganellen, cellen en organismen, repliceren zich.

De kandidaat kan in een context:

1. verbanden leggen tussen replicatie die plaatsvindt op de verschillende organisatieniveaus.

Subdomein E4. Erfelijke eigenschap

Eindterm

De kandidaat kan met behulp van het concept *erfelijke eigenschap* ten minste in contexten op het gebied van veiligheid en voedselproductie verklaren op welke wijze eigenschappen worden overgedragen bij eukaryoten en prokaryoten.

Voorbeeldcontexten

VH: Politie, analisten en laboranten in de forensische laboratoriumpraktijk verzamelen en onderzoeken sporen van de plaats delict volgens *sop's* (standard operating procedure) en doen daarvan verslag ten behoeve van de juridische praktijk.

VP: Laboranten en analisten werken bij een vermeerderingsbedrijf in de groenteteelt aan het maken van weefselkweken van plantencellen met het doel zo snel mogelijk te komen tot voldoende uitgangsmateriaal voor een nieuw groenteras.

E4.1 Erfelijke eigenschap

Specificatie

De kandidaat kan in een context:

1. uitleggen dat een fenotype tot stand komt door de combinatie van genotype en de invloed van milieufactoren;

2. verschillen tussen autosomen en geslachtschromosomen benoemen en toelichten dat bij de mens de geslachtschromosomen het geslacht bepalen;

3. afleiden uit stambomen of kruisingsschema's hoe groot de kans is op het voorkomen van genotypen en fenotypen van nakomelingen bij monohybride kruisingen, voor autosomale en Xchromosomale genen en multipele allelen en lethale factoren;

4. overerving die anders verloopt dan volgens de wetten van Mendel herkennen;

5. ethische en biologische argumenten onderscheiden over het ingrijpen van de mens in de erfelijkheid van mens, dier en plant.

Deelconcepten

genoom, chromosoom, autosomen, geslachtschromosomen, genotype, fenotype, allel, gen, monohybride kruising, (onvolledig) dominant, recessief, intermediair, multipele allelen, lethale factor stamboom, gekoppelde genen, epigenetica.

Domein F. Evolutie

Biologische eenheden zijn op alle organisatieniveaus met elkaar in interactie, beïnvloed door biotische en abiotische factoren. Daarbij is er concurrentie om ruimte, licht, voedsel enzovoorts. De kans om t overleven en nakomelingen te krijgen is het grootst voor biologische eenheden die het best passen bij de omstandigheden, die de omstandigheden kunnen aanpassen of die de beste omstandigheden kunnen opzoeken. Evolutie laat zien hoe toeval, mutatie, recombinatie, variatie, adaptatie en selectiedruk hebben geleid tot de nu aanwezige biodiversiteit.

Syllabus biologie havo centraal examen 2015 24

De kandidaat kan in een context:

· beschrijven hoe diversiteit van leven ontstaan is;

· beschrijven dat het bestaan van de universele genetische code opgevat wordt als een natuurwetenschappelijk argument voor een gemeenschappelijke oorsprong en verwantschap van al het leven;

· de rol van adaptaties in biologische eenheden uitleggen;

· beschrijven hoe de evolutietheorie tot stand gekomen is en de wisselwerking tussen de evolutietheorie en wetenschap, maatschappij en levensovertuiging toelichten.

Subdomein F1. Selectie

Eindterm
De kandidaat kan met behulp van de concepten DNA, mutatie, recombinatie en variatie ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze variatie in populaties tot stand komt.

Voorbeeldcontexten

G: Hulpverleners van een NGO (non-gouvernementele organisatie) laten zich in het tropeninstituut voorlichten over de noodzakelijke profylaxe en inentingen tegen allerlei nieuwe typen ziekten, met het doel niet ziek te worden tijdens een verblijf in de rampregio waar ze hulp gaan verlenen.

VP: (Pre)breeders bij een veredelaar sporen met behulp van protocollen nieuwe eigenschappen op en interpreteren de resultaten van kruisingen, met het doel voedselgewassen plaagresistent te maken of beter te laten smaken.

F1.1 DNA

Specificatie

De kandidaat kan in een context:

1. benoemen dat DNA functioneert als universele drager van genetische informatie;

2. uitleggen dat dezelfde genetische informatie in verschillende organismen voor kan komen;

3. uitleggen dat met gegevens verkregen door DNA-analyse de graad van verwantschap van soorten kan worden vastgesteld.

Deelconcepten

DNA, genetische code, genotype, fenotype.

F1.2 Mutatie

Specificatie

De kandidaat kan in een context:

1. beschrijven welke typen mutatie er zijn;

2. uitleggen waardoor mutatie veroorzaakt kan worden;

3. uitleggen dat mutatie het fenotype kan beïnvloeden;

4. uitleggen dat mutatie plaatsvindt onafhankelijk van het mogelijke effect ervan op overlevingskans of voortplanting van de cel of het organisme.

Deelconcepten

chromosoom, mutagene stof, mutagene straling puntmutatie, genoommutatie, gen, allel, genetische modificatie.

F1.3 Recombinatie

Specificatie

De kandidaat kan in een context:

· beschrijven dat bij geslachtelijke voortplanting voortplantingscellen met een unieke combinatie van genen ontstaan door recombinatie van chromosomen.

Deelconcepten
meiose, homologe chromosomen, autosomen, geslachtschromosomen, karyotype, genoom, gekoppelde genen.

F1.4 Variatie

Specificatie

De kandidaat kan in een context:

1. uitleggen dat genetische variatie in een populatie vergroot wordt door mutatie en recombinatie;

2. uitleggen hoe door de mens gewenste genencombinaties verkregen worden door genetische modificatie.

Deelconcepten

mutatie, recombinatie, fenotype, genotype, genenpool, genetische modificatie.

Subdomein F2. Soortvorming

Eindterm

De kandidaat kan met behulp van de concepten *populatie*, *variatie*, *selectie* en *soortvorming* ten minste in contexten op het gebied van gezondheid en wereldbeeld verklaren op welke wijze nieuwe soorten kunnen ontstaan.

Voorbeeldcontexten

G: Analisten en laboranten in een laboratorium doen door middel van controle- en inventarisatiekweken onderzoek naar de aanwezigheid en verspreiding van MRSA-bacteriën met het doel de medische staf te informeren.

W (leefwereldcontext): Leerlingen voeren in de klas een discussie over de relatie tussen de evolutietheorie en levensbeschouwing/ religieuze opvattingen met het doel om een overzicht te krijgen van mogelijke argumenten en een eigen afweging te maken.

F2.1 Populatie

Specificatie

De kandidaat kan in een context:

1. omschrijven wat onder een populatie wordt verstaan;

2. uitleggen dat frequenties van genotypen en fenotypen in populaties in tijd en ruimt veranderen.

Deelconcepten

Populatie, genotype, fenotype.

F2.2 Variatie

Specificatie

De kandidaat kan in een context:

1. beschrijven wat onder genetische variatie in een populatie wordt verstaan;

2. uitleggen dat genfrequenties in een populatie kunnen veranderen door random mutatie.

Deelconcepten

adaptatie, fitness, natuurlijke selectie, genetic drift.

F2.3 Selectie

Specificatie

De kandidaat kan in een context:

1. uitleggen dat adaptaties van populaties door selectie van organismen tot stand komen;

2. overeenkomsten en verschillen tussen natuurlijke en kunstmatige selectie beschrijven.

Appendix E

Syllabus centraal examen 2016 VWO (p 27 – 30)
Source: www.examenblad.nl
Accessed: 10-12-2012

F EVOLUTIE

Biologische eenheden zijn op alle organisatieniveaus met elkaar in interactie, beïnvloed door biotische en abiotische factoren. Daarbij is er competitie om ruimte, licht, voedsel enzovoorts. De kans om te overleven en nakomelingen te krijgen is het grootst voor biologische eenheden die het best passen bij de omstandigheden, die de omstandigheden kunnen aanpassen of die de beste omstandigheden kunnen opzoeken.

Evolutie laat zien hoe toeval, mutatie, recombinatie, variatie, adaptatie en selectiedruk hebben geleid tot de nu aanwezige biodiversiteit.

De kandidaat kan in een context:

• toelichten hoe biodiversiteit van leven ontstaan is;

• toelichten dat het bestaan van de universele code opgevat wordt als een natuurwetenschappelijk argument voor een gemeenschappelijke oorsprong en verwantschap van al het leven;

• redeneringen hanteren waarbij de rol van adaptaties in biologische eenheden wordt uiteengezet.

• redeneringen hanteren waarbij vanuit een gegeven vorm van een biologische eenheid naar een bijbehorende functie wordt gezocht en toelichten dat een bepaalde functionaliteit langs verschillende wegen in de evolutie ontstaan kan zijn.

• toelichten hoe evolutietheorie tot stand gekomen is en argumenteren over de wisselwerking van de evolutietheorie met wetenschap, maatschappij en levensovertuiging.

F1 SELECTIE

De kandidaat kan met behulp van de concepten DNA, mutatie, genetische variatie, recombinatie en populatie ten minste in contexten op het gebied van duurzaamheid, gezondheid en voedselproductie verklaren op welke wijze variatie in populaties tot stand komt.

Voorbeeld contexten

D: Ecologen van een ecologisch instituut trachten door middel van tellingen en metingen de variatie die in populaties gevonden wordt te verklaren met het doel om meer te weten te komen over natuurlijke selectie en evolutie.

G: Artsen in Japan onderzoeken met behulp van sequencing door verschillende doses straling veroorzaakte mutaties met het doel een optimaal beschermingsadvies te geven bij het werken met

straling.

VP: De plantenveredelaar en de taxonomen van een Instituut Genetische Bronnen ontwikkelen nieuwe rassen van voedingsgewassen met behulp van kennis van taxonomie en veredelingstechnieken en gaan op speurtocht naar genetische bronnen die de voedselgewassen plaagresistent maken of beter laten smaken.

F1.1 DNA

De kandidaat kan in een context:

1.benoemen dat DNA functioneert als universele drager van genetische informatie

2.uitleggen dat dezelfde genetische informatie in verschillende organismen voor kan komen

3.uitleggen hoe door DNA-analyse de graad van verwantschap van soorten kan worden vastgesteld

Deelconcepten

DNA, genetische code, genotype, fenotype

F1.2 MUTATIE

De kandidaat kan in een context:

1. beschrijven welke typen mutatie er zijn

2. uitleggen waardoor mutatie veroorzaakt kan worden

3. uitleggen hoe mutatie het fenotype kan beïnvloeden

4. uitleggen dat mutatie plaatsvindt onafhankelijk van het mogelijke effect ervan op overlevingskans of voortplanting van de cel of het organisme

Deelconcepten

adaptatie, fitness, natuurlijke selectie, genetic drift, gene flow, allelfrequentie, Hardy-Weinberg

F2.3 SELECTIE

De kandidaat kan in een context:

1. uitleggen dat aanpassingen van populaties door selectie van organismen tot stand komen

2. uitleggen dat selectiedruk adaptaties bijeen brengt die het voortplantingssucces van de soort vergroten

3. overeenkomsten en verschillen tussen natuurlijke en kunstmatige selectie beschrijven.

Deelconcepten

adaptatie, fitness, selectiedruk, soort, natuurlijke selectie, seksuele selectie, eilandtheorie, founder effect, flessehalseffect

F2.4 SOORTVORMING

De kandidaat kan in een context:

1. beschrijven dat soorten groepen individuen zijn die reproductief van elkaar geïsoleerd zijn

2. uitleggen dat populaties divergeren door genetic drift, mutatie en selectie

Appendix F

Staatscourant nr. 11101, 6 juni 2012
Source: www.staatscourant.nl
Accessed: 10-12-2012

STAATSCOURANT

Officiële uitgave van het Koninkrijk der Nederlanden sinds 1814. **1 Staatscourant**

Nr. 11101 6 juni, 2012

Regeling van de Minister van Onderwijs, Cultuur en Wetenschap van 28 april 2012, nr. VO/389632, houdende wijziging van de Regeling examenprogramma's voortgezet onderwijs in verband met het vernieuwen van de examenprogramma's natuurkunde havo en vwo en biologie havo en vwo

De Minister van Onderwijs, Cultuur en Wetenschap,Gelet op artikel 7 van het Eindexamenbesluit v.w.o.- h.a.v.o.- m.a.v.o.- v.b.o. ;Besluit:

ARTIKEL I. WIJZIGING REGELING EXAMENPROGRAMMA'S VOORTGEZET ONDERWIJS

In Bijlage 1 van de Regeling examenprogramma's voortgezet onderwijs worden de examenprogramma's natuurkunde havo en vwo en biologie havo en vwo vervangen door de bij deze regeling horende bijlagen.

ARTIKEL II. OVERGANGSBEPALINGEN

1.De wijziging die deze regeling aanbrengt in bijlage I van de Regeling examenprogramma's voortgezet onderwijs, is in het schooljaar 2013–2014 niet van toepassing op leerlingen die op 1 augustus 2013 zijn toegelaten tot het vijfde leerjaar havo dan wel het vijfde of zesde leerjaar vwo.2.In het schooljaar 2014–2015 wordt voor de eerste maal de gelegenheid geboden tot het afleggen van een examen natuurkunde havo op basis van het examenprogramma zoals beschreven in de bij deze regeling behorende bijlage 1, en wordt voor de laatste maal de gelegenheid geboden tot het afleggen van een examen natuurkunde havo op basis van het examenprogramma zoals dat luidde vóór inwerkingtreding van deze regeling.3.In het schooljaar 2015–2016 wordt voor de eerste maal de gelegenheid geboden tot het afleggen van een examen natuurkunde vwo op basis van het examenprogramma zoals beschreven in de bij deze regeling behorende bijlage 2, en wordt voor de laatste maal de gelegenheid geboden tot het afleggen van een examen natuurkunde vwo op basis van het examenprogramma zoals dat luidde vóór inwerkingtreding van deze regeling.4.In het schooljaar 2014–2015 wordt voor de eerste maal de gelegenheid geboden tot het afleggen van een examen biologie havo op basis van het examenprogramma zoals beschreven in de bij deze regeling behorende bijlage 3, en wordt voor de laatste maal de gelegenheid geboden tot het afleggen van een examen biologie havo op basis van het examenprogramma zoals dat luidde vóór inwerkingtreding van deze regeling.5.In het schooljaar 2015–2016 wordt voor de eerste maal de gelegenheid geboden tot het afleggen van een examen biologie vwo op basis van het examenprogramma zoals beschreven in de bij deze regeling behorende bijlage 4, en wordt voor de laatste maal de gelegenheid geboden tot het

afleggen van een examen biologie vwo op basis van het examenprogramma zoals dat luidde vóór inwerkingtreding van deze regeling.

ARTIKEL III. INWERKINGTREDING

Deze regeling treedt in werking met ingang van 1 augustus 2013.

Deze regeling zal met de toelichting in de Staatscourant worden geplaatst.*De Minister van Onderwijs, Cultuur en Wetenschap,M. van Bijsterveldt-Vliegenthart.*

TOELICHTING

In bijlage 1 van de Regeling examenprogramma's voortgezet onderwijs worden de examenprogramma's natuurkunde havo en vwo en biologie havo en vwo vervangen door nieuwe examenprogramma's voor deze vakken.1.Op basis van de adviezen van de Commissie Vernieuwing Natuurkunde Onderwijs havo/vwo en de Commissie Vernieuwing Biologie Onderwijs (2010) en de resultaten van de evaluatie van de pilots op scholen met de nieuwe programma's (SLO 2011) worden deze examenprogramma's ingevoerd voor havo en vwo op 1 augustus 2013, te beginnen in het 4e leerjaar. De eerste examens natuur-kunde havo en biologie havo op basis van deze nieuwe examenprogramma's vinden plaats aan het eind van schooljaar 2014–2015, en die voor vwo aan het eind van schooljaar 2015–2016.2.De leerlingen die in 2014 zakken voor het examen natuurkunde havo, kunnen in 2015 voor de laatste maal het examen afleggen volgens het oude examenprogramma natuurkunde havo.3.De leerlingen die in 2015 zakken voor het examen natuurkunde vwo, kunnen in 2016 voor de laatste maal het examen afleggen volgens het oude examenprogramma natuurkunde vwo.4.De leerlingen die in 2014 zakken voor het examen biologie havo, kunnen in 2015 voor de laatste maal het examen afleggen volgens het oude examenprogramma biologie havo.5.De leerlingen die in 2015 zakken voor het examen biologie vwo, kunnen in 2016 voor de laatste maal het examen afleggen volgens het oude examenprogramma biologie vwo.De Minister van Onderwijs, Cultuur en Wetenschap,M. van Bijsterveldt-Vliegenthart.

BIJLAGE 3

Examenprogramma Biologie Havo Het eindexamen. Het eindexamen bestaat uit het centraal examen en het schoolexamen.

Het examenprogramma bestaat uit de volgende domeinen:

Domein A Vaardigheden

Domein B Zelfregulatie

Domein C Zelforganisatie

Domein D Interactie

Domein E Reproductie

Domein F Evolutie

Het centraal examen

Het centraal examen heeft betrekking op de subdomeinen B2, B3, B4, B5, B7, B8, C1, D4, E4, F1 en F2, in combinatie met de vaardigheden uit domein A. Het CvE kan bepalen dat het centraal examen ten dele betrekking heeft op andere subdomeinen, mits de subdomeinen van het centraal examen tezamen dezelfde studielast hebben als de in de vorige zin genoemde. Het CvE stelt het aantal en de tijdsduur van de zittingen van het centraal examen vast. Het CvE maakt indien nodig een specificatie bekend van de examenstof van het centraal examen.

Het schoolexamen

Het schoolexamen heeft betrekking op domein A en:–de domeinen en subdomeinen waarop het centraal examen geen betrekking heeft;–indien het bevoegd gezag daarvoor kiest: een of meerdere domeinen of subdomeinen waarop het centraal examen betrekking heeft;–indien het bevoegd gezag daarvoor kiest: andere vakonderdelen die per kandidaat kunnen verschillen.

De examenstof *Domein A: Vaardigheden Algemene vaardigheden (profieloverstijgend niveau)*

Subdomein A1:

Informatievaardigheden gebruiken

1.De kandidaat kan doelgericht informatie zoeken, beoordelen, selecteren en verwerken.

Subdomein A2:

Communiceren

2.De kandidaat kan adequaat schriftelijk, mondeling en digitaal in het publieke domein communiceren over onderwerpen uit het desbetreffende vakgebied.Subdomein A3: Reflecteren op leren

3.De kandidaat kan bij het verwerven van vakkennis en vakvaardigheden reflecteren op eigen belangstelling, motivatie en leerproces.

Subdomein A4:

Studie en beroep

4.De kandidaat kan aangeven op welke wijze natuurwetenschappelijke kennis in studie en beroep wordt gebruikt en kan mede op basis daarvan zijn belangstelling voor studies en beroepen onder woorden brengen.

Natuurwetenschappelijke, wiskundige en technische vaardigheden (bètaprofielniveau)

Subdomein A5:

Onderzoeken

5.De kandidaat kan in contexten instructies voor onderzoek op basis van vraagstellingen uitvoeren en conclusies trekken uit de onderzoeksresultaten. De kandidaat maakt daarbij gebruik van consistente redeneringen en relevante rekenkundige en wiskundige vaardigheden.

Subdomein A6:

Ontwerpen

6.De kandidaat kan in contexten op basis van een gesteld probleem een technisch ontwerp voorbereiden, uitvoeren, testen en evalueren en daarbij relevante begrippen, theorie en vaardigheden en valide en consistente redeneringen hanteren.

Subdomein A7:

Modelvorming

7. De kandidaat kan in contexten een probleem analyseren, een adequaat model selecteren, en modeluitkomsten genereren en interpreteren. De kandidaat maakt daarbij gebruik van consistente redeneringen en relevante rekenkundige en wiskundige vaardigheden.

Subdomein A8:

Natuurwetenschappelijk instrumentarium

8.De kandidaat kan in contexten een voor de natuurwetenschappen relevant instrumentarium hanteren, waar nodig met aandacht voor risico's en veiligheid; daarbij gaat het om instrumenten voor dataverzameling en -bewerking, vaktaal, vakconventies, symbolen, formuletaal en rekenkun-dige bewerkingen.

Subdomein A9:

Waarderen en oordelen

9.De kandidaat kan in contexten een beargumenteerd oordeel geven over een situatie in de natuur of een technische toepassing, en daarin onderscheid maken tussen wetenschappelijke argumenten,

normatieve maatschappelijke overwegingen en persoonlijke opvattingen.*Biologie – specifieke vaardigheden*

Subdomein A10:

Beleven

10.De kandidaat kan in contexten gevoelens en betekenissen expliciteren die worden opgeroepen door het omgaan met de natuur of in de natuur voorkomende objecten en daarbij aandacht schenken aan de gevoelens en betekenissen van anderen.

Subdomein A11:

Vormfunctiedenken

11.De kandidaat kan in contexten redeneringen hanteren waarbij van biologische objecten op verschillende organisatieniveaus vanuit een gegeven vorm naar een bijbehorende functie wordt gezocht en andersom.

Subdomein A12:

Ecologisch denken

12.De kandidaat kan in contexten op het gebied van duurzaamheid redeneringen hanteren waarbij uitgewerkt wordt wat de gevolgen van interne of externe veranderingen in een levensgemeen-schap of ecosysteem zijn.

Subdomein A13:

Evolutionair denken

13.De kandidaat kan in contexten redeneringen hanteren waarmee biologische verschijnselen op verschillende organisatieniveaus verklaard worden met behulp van theorie over evolutiemechanis-men.

Subdomein A14:

Systeemdenken

14.De kandidaat kan in contexten een onderscheid maken tussen verschillende organisatieniveaus, relaties binnen en tussen organisatieniveaus uitwerken en uiteenzetten hoe biologische eenheden op verschillende organisatieniveaus zichzelf in stand houden en ontwikkelen.

Subdomein A15:

Contexten

15.De kandidaat kan de in domein A genoemde vaardigheden en de in domeinen B tot en met F genoemde concepten ten minste gebruiken in beroepscontexten en in leefwereldcontexten.

Subdomein A16:

Kennisontwikkeling en toepassing

16.De kandidaat kan in contexten analyseren op welke wijze natuurwetenschappelijke en technologische kennis wordt ontwikkeld en toegepast.

Domein B: Zelfregulatie

Subdomein B1:

Eiwitsynthese

17.De kandidaat kan met behulp van de concepten DNA en eiwitsynthese ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze bouwstoffen van de cel worden gevormd.

Subdomein B2:

Stofwisseling van de cel

18.De kandidaat kan met behulp van de concepten homeostase, transport, assimilatie en dissimilatie ten minste in contexten op het gebied van gezondheid en voeding verklaren op welke wijze de stofwisseling van cellen van prokaryoten en eukaryoten verloopt.

Subdomein B3:

Stofwisseling van het organisme

19.De kandidaat kan met behulp van de concepten orgaan, fotosynthese, ademhaling, vertering, uitscheiding en transport ten minste in contexten op het gebied van gezondheid en voedselpro-ductie benoemen op welke wijze de stofwisseling van organismen verloopt en benoemen op welke wijze stoornissen daarin kunnen ontstaan en op welke wijze deze kunnen worden aangepakt.

Subdomein B4:

Zelfregulatie van het organisme

20.De kandidaat kan met behulp van de concepten homeostase, hormonale regulatie en neurale regulatie ten minste in contexten op het gebied van sport en voeding verklaren op welke wijze eukaryoten zichzelf reguleren.

Subdomein B5:

Afweer van het organisme

21.De kandidaat kan met behulp van het concept afweer ten minste in contexten op het gebied van gezondheidszorg en voedselproductie benoemen op welke wijze eukaryoten zich te weer stellen tegen andere organismen, virussen en allergenen en welke problemen daarbij kunnen ontstaan.

Subdomein B6:

Beweging van het organisme

22.De kandidaat kan met behulp van de concepten beweging, neurale regulatie en waarneming ten minste in contexten op het gebied van gezondheid en sport verklaren op welke wijze mens en dier bewegen en op welke wijze dit kan worden geoptimaliseerd.

Subdomein B7:

Waarneming door het organisme

23.De kandidaat kan met behulp van de concepten orgaan, waarneming en neurale regulatie ten minste in contexten op het gebied van gezondheid en sport verklaren op welke wijze organismen waarnemen.

Subdomein B8:

Regulatie van ecosystemen

24.De kandidaat kan met behulp van de concepten energiestroom, kringloop, dynamiek en evenwicht ten minste in contexten op het gebied van duurzaamheid verklaren op welke wijze ecosystemen zichzelf reguleren en kan beargumenteren met welke maatregelen de mens zelfregulatie van ecosystemen en het systeem Aarde kan beïnvloeden.

Domein C:

Zelforganisatie

Subdomein C1:

Zelforganisatie van cellen

25.De kandidaat kan met behulp van de concepten genexpressie en celdifferentiatie ten minste in contexten op het gebied van energie en gezondheid benoemen op welke wijze de ontwikkeling van cellen verloopt.

Subdomein C2:

Zelforganisatie van het organisme

26.De kandidaat kan met behulp van het concept levenscyclus ten minste in contexten op het gebied van gezondheid en voedselproductie benoemen op welke wijze de ontwikkeling van organismen verloopt en verklaren op welke wijze verstoringen van de ontwikkeling ontstaan, kunnen worden voorkomen en worden aangepakt.

Subdomein C3:

Zelforganisatie van ecosystemen

27.De kandidaat kan met behulp van de concepten dynamiek en evenwicht ten minste in contexten op het gebied van duurzaamheid en wereldbeeld benoemen op welke wijze ecosystemen zich kunnen ontwikkelen en beargumenteren met welke maatregelen de mens de zelforganisatie van ecosystemen beïnvloedt.

Domein D:

Interactie

Subdomein D1:

Moleculaire interactie

28.De kandidaat kan met behulp van de concepten genregulatie en interactie met (a)biotische factoren ten minste in contexten op het gebied van gezondheid en voedselproductie benoemen op welke wijze de moleculaire regulatie plaatsvindt.

Subdomein D2:

Gedrag en interactie

29.De kandidaat kan met behulp van de concepten gedrag en interactie met (a)biotische factoren ten minste in contexten op het gebied van communicatie, gezondheid en veiligheid verklaren op welke wijze gedrag van organismen en populaties ontstaat en benoemen wat de functie daarvan is.

Subdomein D3:

Seksualiteit

30.De kandidaat kan met behulp van de concepten gedrag en interactie met (a)biotische factoren ten minste in contexten op het gebied van gezondheid en communicatie beargumenteren op welke wijze vraagstukken met betrekking tot seksualiteit van de mens kunnen worden benaderd.

Subdomein D4:

Interactie in ecosystemen

31.De kandidaat kan met behulp van de concepten voedselrelatie en interactie met (a)biotische factoren ten minste in contexten op het gebied van duurzaamheid en voedselproductie benoemen welke relaties tussen populaties in ecosystemen bestaan en beargumenteren op welke wijze vraagstukken die daar betrekking op hebben, kunnen worden benaderd.

Domein E:

Reproductie

Subdomein E1:

DNAreplicatie

32.De kandidaat kan met behulp van het concept DNA-replicatie ten minste in contexten op het gebied van veiligheid en gezondheid benoemen op welke wijze erfelijk materiaal wordt gereproduceerd.

Subdomein E2:

Levenscyclus van de cel

33.De kandidaat kan met behulp van het concept celcyclus ten minste in contexten op het gebied van energie, gezondheid en voedselproductie benoemen op welke wijze reproductie van cellen verloopt.

Subdomein E3:

Voortplanting van het organisme

34.De kandidaat kan met behulp van het concept voortplanting ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze de reproductie van eukaryoten en prokaryoten verloopt.

Subdomein E4:

Erfelijke eigenschap

35.De kandidaat kan met behulp van het concept erfelijke eigenschap ten minste in contexten op het gebied van veiligheid en voedselproductie verklaren op welke wijze eigenschappen worden overgedragen bij eukaryoten en prokaryoten.

Domein F:

Evolutie

Subdomein F1:

Selectie

36.De kandidaat kan met behulp van de concepten DNA, mutatie, recombinatie en variatie ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze variatie in populaties tot stand komt.

Subdomein F2:

Soortvorming

37.De kandidaat kan met behulp van de concepten populatie, variatie, selectie en soortvorming ten minste in contexten op het gebied van gezondheid en wereldbeeld verklaren op welke wijze nieuwe soorten kunnen ontstaan.

Subdomein F3:

Biodiversiteit

38.De kandidaat kan met behulp van het concept biodiversiteit ten minste in contexten op het gebied van duurzaamheid benoemen op welke wijze de diversiteit van populaties en ecosystemen binnen het systeem Aarde varieert.

BIJLAGE 4

Examenprogramma biologie VWO Het eindexamenHet eindexamen bestaat uit het centraal examen en het schoolexamen.

Het examenprogramma bestaat uit de volgende domeinen:Domein A VaardighedenDomein B ZelfregulatieDomein C ZelforganisatieDomein D InteractieDomein E ReproductieDomein F EvolutieHet centraal examenHet centraal examen heeft betrekking op de subdomeinen B1, B2, B3, B4, B5, B8, C1, C3, D1, D2, D5, E3, F1 en F2, in combinatie met de vaardigheden uit domein A.

Het CvE kan bepalen dat het centraal examen ten dele betrekking heeft op andere subdomeinen, mits de subdomeinen van het centraal examen tezamen dezelfde studielast hebben als de in de vorige zin genoemde.

Het CvE stelt het aantal en de tijdsduur van de zittingen van het centraal examen vast.Het CvE maakt indien nodig een specificatie bekend van de examenstof van het centraal examen.

Het schoolexamen

Het schoolexamen heeft betrekking op domein A en:–de domeinen en subdomeinen waarop het centraal examen geen betrekking heeft;–indien het bevoegd gezag daarvoor kiest: een of meerdere domeinen of subdomeinen waarop het centraal examen betrekking heeft;–indien het bevoegd gezag daarvoor kiest: andere vakonderdelen die per kandidaat kunnen verschillen.De examenstof *Domein A: Vaardigheden Algemene vaardigheden (profieloverstijgend niveau)*

Subdomein A1: Informatievaardigheden gebruiken1.De kandidaat kan doelgericht informatie zoeken, beoordelen, selecteren en verwerken.

Subdomein A2: Communiceren2.De kandidaat kan adequaat schriftelijk, mondeling en digitaal in het publieke domein communice-ren over onderwerpen uit het desbetreffende vakgebied.

Subdomein A3: Reflecteren op leren3.De kandidaat kan bij het verwerven van vakkennis en vakvaardigheden reflecteren op eigen belangstelling, motivatie en leerproces.

Subdomein A4: Studie en beroep4.De kandidaat kan aangeven op welke wijze natuurwetenschappelijke kennis in studie en beroep wordt gebruikt en kan mede op basis daarvan zijn belangstelling voor studies en beroepen onder woorden brengen.

Natuurwetenschappelijke, wiskundige en technische vaardigheden (bètaprofielniveau)

Subdomein A5: Onderzoeken5.De kandidaat kan in contexten vraagstellingen analyseren, gebruikmakend van relevante begrip-pen en theorie, vertalen in een vakspecifiek onderzoek, dat onderzoek uitvoeren, en uit de onderzoeksresultaten conclusies trekken. De kandidaat maakt daarbij gebruik van consistente redeneringen en relevante rekenkundige en wiskundige vaardigheden.

Subdomein A6: Ontwerpen6.De kandidaat kan in contexten op basis van een gesteld probleem een technisch ontwerp voorbereiden, uitvoeren, testen en evalueren en daarbij relevante begrippen, theorie en vaardigheden en valide en consistente redeneringen hanteren.

Subdomein A7:

Modelvorming

7.De kandidaat kan in contexten een relevant probleem analyseren, inperken tot een hanteerbaar probleem, vertalen naar een model, modeluitkomsten genereren en interpreteren, en het model toetsen en beoordelen. De kandidaat maakt daarbij gebruik van consistente redeneringen en relevante rekenkundige en wiskundige vaardigheden.

Subdomein A8:

Natuurwetenschappelijk instrumentarium

8.De kandidaat kan in contexten een voor de natuurwetenschappen relevant instrumentarium hanteren, waar nodig met aandacht voor risico's en veiligheid; daarbij gaat het om instrumenten voor dataverzameling en -bewerking, vaktaal, vakconventies, symbolen, formuletaal en rekenkun-dige bewerkingen.

Subdomein A9:

Waarderen en oordelen

9.De kandidaat kan in contexten een beargumenteerd oordeel geven over een situatie in de natuur of een technische toepassing, en daarin onderscheid maken tussen wetenschappelijke argumenten, normatieve maatschappelijke overwegingen en persoonlijke opvattingen.*Biologie – specifieke vaardigheden*

Subdomein A10:

Beleven

10.De kandidaat kan in contexten gevoelens en betekenissen expliciteren die worden opgeroepen door het omgaan met de natuur of in de natuur voorkomende objecten en daarbij aandacht schenken aan de gevoelens en betekenissen van anderen.

Subdomein A11: Vormfunctiedenken11.De kandidaat kan in contexten redeneringen hanteren waarbij van biologische objecten op verschillende organisatieniveaus vanuit een gegeven vorm naar een bijbehorende functie wordt gezocht en andersom.

Subdomein A12:

Ecologisch denken

12.De kandidaat kan in contexten op het gebied van duurzaamheid redeneringen hanteren waarbij uitgewerkt wordt wat de gevolgen van interne of externe veranderingen in een levensgemeen-schap of ecosysteem zijn.

Subdomein A13:

Evolutionair denken

13.De kandidaat kan in contexten redeneringen hanteren waarmee biologische verschijnselen op verschillende organisatieniveaus verklaard worden met behulp van theorie over evolutiemechanismen.

Subdomein A14:

Systeemdenken

14.De kandidaat kan in contexten een onderscheid maken tussen verschillende organisatieniveaus, relaties binnen en tussen organisatieniveaus uitwerken en uiteenzetten hoe biologische eenheden op verschillende organisatieniveaus zichzelf in stand houden en ontwikkelen.

Subdomein A15:

Kennisontwikkeling en –toepassing

15.De kandidaat kan in contexten analyseren op welke wijze natuurwetenschappelijke en technologische kennis wordt ontwikkeld en toegepast.

Subdomein A16:

Contexten

16.De kandidaat kan de in domein A genoemde vaardigheden en de in domeinen B tot en met F genoemde concepten ten minste gebruiken in wetenschappelijke contexten, in beroepscontexten waarvoor een wetenschappelijke opleiding is vereist en in leefwereldcontexten.

Domein B:

Zelfregulatie

Subdomein B1:

Eiwitsynthese

17.De kandidaat kan met behulp van de concepten DNA en eiwitsynthese ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze zelfregulatie op moleculair niveau plaatsvindt.

Subdomein B2:

Stofwisseling van de cel

18.De kandidaat kan met behulp van de concepten homeostase, transport, assimilatie en dissimilatie ten minste in contexten op het gebied van gezondheid en voeding verklaren op welke wijze de stofwisseling van cellen van prokaryoten en eukaryoten verloopt.

Subdomein B3:

Stofwisseling van het organisme

19.De kandidaat kan met behulp van de concepten orgaan, fotosynthese, ademhaling, vertering, uitscheiding en transport ten minste in contexten op het gebied van gezondheid en voedselpro-ductie

verklaren op welke wijze de stofwisseling van organismen verloopt en beargumenteren op welke wijze stoornissen daarin kunnen ontstaan en op welke wijze deze kunnen worden aangepakt.

Subdomein B4:

Zelfregulatie van het organisme

20.De kandidaat kan met behulp van de concepten homeostase, hormonale regulatie en neurale regulatie ten minste in contexten op het gebied van sport en voeding verklaren op welke wijze zelfregulatie bij eukaryoten verloopt en beargumenteren op welke wijze daarin stoornissen kunnen ontstaan en op welke wijze deze kunnen worden aangepakt.

Subdomein B5:

Afweer van het organisme

21.De kandidaat kan met behulp van het concept afweer ten minste in contexten op het gebied van gezondheidszorg en voedselproductie benoemen op welke wijze organismen zich te weer stellen tegen andere organismen, virussen en allergenen en beargumenteren welke problemen daarbij kunnen optreden en op welke wijze deze kunnen worden aangepakt.

Subdomein B6:

Beweging van het organisme

22.De kandidaat kan met behulp van de concepten beweging, neurale regulatie en waarneming ten minste in contexten op het gebied van gezondheid en sport verklaren op welke wijze mens en dier bewegen en op welke wijze dit kan worden geoptimaliseerd.

Subdomein B7:

Waarneming door het organisme

23.De kandidaat kan met behulp van de concepten orgaan, waarneming en neurale regulatie ten minste in contexten op het gebied van gezondheid en sport verklaren op welke wijze organismen waarnemen.

Subdomein B8:

Regulatie van ecosystemen

24.De kandidaat kan met behulp van de concepten energiestroom, kringloop, dynamiek en evenwicht ten minste in contexten op het gebied van duurzaamheid verklaren op welke wijze ecosystemen zichzelf reguleren; de kandidaat kan beargumenteren welke effecten op kunnen treden als zelfregulatie van ecosystemen en het systeem Aarde wordt verstoord, en kan beargumenteren met welke maatregelen de mens zelfregulatie van ecosystemen en het systeem Aarde kan beïnvloeden.

Domein C:

Zelforganisatie

Subdomein C1:

Zelforganisatie van cellen

25.De kandidaat kan met behulp van de concepten genexpressie en celdifferentiatie ten minste in contexten op het gebied van gezondheid en voedselproductie benoemen op welke wijze de ontwikkeling van cellen verloopt en beargumenteren op welke wijze stoornissen in de ontwikkeling kunnen ontstaan en worden aangepakt.

Subdomein C2:

Zelforganisatie van het organisme

26.De kandidaat kan met behulp van het concept levenscyclus ten minste in contexten op het gebied van gezondheid en voedselproductie benoemen op welke wijze de ontwikkeling van organismen verloopt, verklaren op welke wijze verstoringen van de ontwikkeling ontstaan en beargumenteren op welke wijze deze kunnen worden voorkomen of worden aangepakt.

Subdomein C3:

Zelforganisatie van ecosystemen

27.De kandidaat kan met behulp van de concepten dynamiek en evenwicht ten minste in contexten op het gebied van duurzaamheid en wereldbeeld benoemen op welke wijze ecosystemen zich kunnen ontwikkelen en beargumenteren met welke maatregelen de mens de zelforganisatie van ecosystemen en het systeem Aarde beïnvloedt.

Domein D:

Interactie

Subdomein D1:

Moleculaire interactie

28.De kandidaat kan met behulp van de concepten genregulatie en interactie met (a)biotische factoren ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze de moleculaire regulatie plaatsvindt.

Subdomein D2:

Cellulaire interactie

29.De kandidaat kan met behulp van de concepten celcommunicatie en interactie met (a)biotische factoren ten minste in contexten op het gebied van gezondheid de wijze waarop cellulaire interactie verloopt benoemen.

Subdomein D3:

Gedrag en interactie

30.De kandidaat kan met behulp van de concepten gedrag en interactie met (a)biotische factoren ten minste in contexten op het gebied van communicatie, gezondheid en veiligheid verklaren op welke wijze gedrag van organismen en populaties ontstaat, benoemen wat de functie van het gedrag is en benoemen op welke wijze het zich ontwikkelt.

Subdomein D4:

Seksualiteit

31.De kandidaat kan met behulp van de concepten gedrag en interactie met (a)biotische factoren ten minste in contexten op het gebied van gezondheid en communicatie beargumenteren op welke wijze vraagstukken met betrekking tot seksualiteit van de mens kunnen worden benaderd.

Subdomein D5:

Interactie in ecosystemen

32.De kandidaat kan met behulp van de concepten voedselrelatie en interactie met (a)biotische factoren ten minste in contexten op het gebied van duurzaamheid en voedselproductie benoemen welke relaties tussen populaties en ecosystemen bestaan en beargumenteren op welke wijze vraagstukken die daar betrekking op hebben, kunnen worden benaderd.

Domein E:

Reproductie

Subdomein E1:

DNAreplicatie

33.De kandidaat kan met behulp van het concept DNA-replicatie ten minste in contexten op het gebied van veiligheid en gezondheid benoemen op welke wijze erfelijk materiaal wordt gereproduceerd.

Subdomein E2: Levenscyclus van de cel

34.De kandidaat kan met behulp van het concept celcyclus ten minste in contexten op het gebied van energie, gezondheid en voedselproductie benoemen op welke wijze reproductie van cellen verloopt en beargumenteren op welke wijze daarbij optredende verstoringen kunnen worden voorkomen of aangepakt.

Subdomein E3:

Reproductie van het organisme

35.De kandidaat kan met behulp van de concepten voortplanting en erfelijke eigenschap ten minste in contexten op het gebied van energie, gezondheid en voedselproductie verklaren op welke wijze eigenschappen worden overgedragen en benoemen op welke wijze de reproductie van eukaryoten en prokaryoten verloopt.

Domein F:

Evolutie

Subdomein F1:

Selectie

36.De kandidaat kan met behulp van de concepten DNA, mutatie, genetische variatie, recombinatie en populatie ten minste in contexten op het gebied van gezondheid en voedselproductie verklaren op welke wijze variatie in populaties tot stand komt.

Subdomein F2:

Soortvorming

37.De kandidaat kan met behulp van de concepten populatie, variatie, selectie en soortvorming ten minste in contexten op het gebied van gezondheid en wereldbeeld verklaren op welke wijze nieuwe soorten kunnen ontstaan.

Subdomein F3:

Biodiversiteit

38.De kandidaat kan met behulp van het concept biodiversiteit ten minste in contexten op het gebied van duurzaamheid en wereldbeeld veranderingen in diversiteit van populaties en ecosystemen binnen het systeem Aarde verklaren en beargumenteren op welke wijze deze veranderingen beïnvloed worden.

Subdomein F4:

Ontstaan van het leven

39.De kandidaat kan met behulp van het concept ontstaan van het leven ten minste in contexten op het gebied van wereldbeeld benoemen met behulp van welke theorie het voorkomen van leven op Aarde wordt verklaard.

Appendix G

Text: Current terms of the exam program for VWO
Source: www.examenblad.nl
Accessed: 23-11-2012

Examenprogramma biologie

vwo

Het eindexamen

Het eindexamen bestaat uit het centraal examen en het schoolexamen. Het examenprogramma bestaat uit de volgende domeinen:

Domein A Vaardigheden

Domein B Structuren van ecosystemen, organismen en cellen

Domein C Levenscyclus en erfelijke informatie

Domein D Metabolisme

Domein E Dynamiek en homeostase.

Het centraal examen

Het centraal examen heeft betrekking op de subdomeinen B1, C1, D1, D3, D4, D5, E2, E4 en E5, in combinatie met de vaardigheden uit domein A. De CEVO kan bepalen, dat het centraal examen ten dele betrekking heeft op andere subdomeinen, mits de subdomeinen van het centraal examen tezamen dezelfde studielast hebben als de in de vorige zin genoemde. De CEVO stelt het aantal en de tijdsduur van de zittingen van het centraal examen vast. De CEVO maakt indien nodig een specificatie bekend van de examenstof van het centraal examen.

Het schoolexamen

Het schoolexamen heeft betrekking op domein A en de domeinen en subdomeinen waarop het centraal examen geen betrekking heeft; indien het bevoegd gezag daarvoor kiest: een of meer domeinen of subdomeinen waarop het centraal examen betrekking heeft; indien het bevoegd gezag daarvoor kiest: andere vakonderdelen, die per kandidaat kunnen verschillen.

De examenstof

Domein A: Vaardigheden
Subdomein A1: Taalvaardigheden

1. De kandidaat kan adequaat schriftelijk en mondeling communiceren over natuurwetenschappelijke onderwerpen.

Subdomein A2: Reken-/wiskundige vaardigheden

2. De kandidaat kan een aantal voor het vak relevante reken-/wiskundige vaardigheden toepassen om natuurwetenschappelijke problemen op te lossen.

Subdomein A3: Informatievaardigheden

3. De kandidaat kan, mede met behulp van ICT, informatie selecteren, verwerken, beoordelen en presenteren.

Subdomein A4: Technisch-instrumentele vaardigheden

4. De kandidaat kan op een verantwoorde manier omgaan met voor het vak relevante organismen en stoffen, instrumenten, apparaten en ICT toepassingen.

Subdomein A5: Ontwerpvaardigheden

5. De kandidaat kan een technisch ontwerp voorbereiden, uitvoeren, testen en evalueren.

Subdomein A6: Onderzoeksvaardigheden

6. De kandidaat kan een natuurwetenschappelijk onderzoek voorbereiden, uitvoeren, de verzamelde onderzoeksresultaten verwerken en hieruit een conclusie trekken.

Subdomein A7: Maatschappij, studie en beroep

7. De kandidaat kan toepassingen en effecten van natuurwetenschappen en techniek in verschillende maatschappelijke situaties herkennen en benoemen. Tevens kan hij een verband leggen tussen de praktijk van verschillende beroepen en de eigen kennis, vaardigheden en attitude.

Subdomein A8: Vaardigheden, specifiek voor biologie

8. De kandidaat kan biologische verschijnselen op verschillende organisatieniveaus met elkaar in verband brengen en de complexiteit van deze relaties aangeven.

Domein B: Structuren van ecosystemen, organismen en cellen

Subdomein B1: Structuren van ecosystemen

9. De kandidaat kan de betekenis en onderlinge wisselwerking van abiotische en biotische factoren, waardoor de diversiteit tussen en binnen ecosystemen wordt bepaald, aangeven en uitleggen.

Subdomein B2: Structuren van cellen

10. De kandidaat kan cellen en delen van cellen herkennen en de functies benoemen, en daarbij de relatie leggen met hogere en lagere organisatieniveaus.

Domein C: Levenscyclus en erfelijke informatie

Subdomein C1: Erfelijkheid

11. De kandidaat kan erfelijkheid op organismeniveau verklaren door het beschrijven van erfelijkheidsprocessen op lagere organisatieniveaus en kan het ingrijpen door de mens in erfelijkheidsprocessen bediscussiëren.

Subdomein C2: Levenscyclus van de mens

12. De kandidaat kent de feiten van de menselijke voortplanting en ontwikkeling en de hormonale regeling hiervan, kent de methoden van anticonceptie, en kan een beargumenteerde mening geven over de betekenis van seksualiteit op biologisch, medisch, maatschappelijk en persoonlijk vlak.

Subdomein C3: Levenscyclus van cellen

13. De kandidaat kent de celcyclus en de invloeden uit het interne en externe milieu op de celcyclus, en kan daarbij een relatie leggen met andere organisatieniveaus.

Domein D: Metabolisme

Subdomein D1: Energiestromen en kringlopen

14. De kandidaat kan energiestromen en kringlopen van stoffen in een ecosysteem beschrijven, en kan aangeven welke factoren daarop van invloed zijn en wat oorzaken en gevolgen zijn van verstoring.

Subdomein D2: Metabolisme van planten

15. De kandidaat kan aangeven hoe organen, weefsels en cellen van planten betrokken zijn bij opname, verwerking, transport en opslag van stoffen, en factoren bespreken die daarop van invloed zijn.

Subdomein D3: Metabolisme van de mens

16. De kandidaat kan aangeven hoe organen, weefsels en cellen van de mens betrokken zijn bij opname, verwerking, transport, opslag en uitscheiding van stoffen, heeft inzicht in de moleculaire processen die daarbij een rol spelen en kan factoren bespreken die hierop van invloed kunnen zijn.

Subdomein D4: Celprocessen

17. De kandidaat kan verschillende celprocessen, onder andere assimilatie- en dissimilatieprocessen, onderscheiden en in verband brengen met verschillende organisatieniveaus, en aangeven welke factoren daarop van invloed zijn.

Subdomein D5: Eiwitsynthese en biotechnologie

18. De kandidaat kan uitleggen hoe onder andere DNA en RNA betrokken zijn bij de eiwitsynthese, heeft inzicht in de werking van enzymen en factoren die enzymwerking beïnvloeden en kan een relatie leggen tussen deze processen en erfelijkheid.

Domein E: Dynamiek en homeostase

Subdomein E1: Dynamiek in ecosystemen

19. De kandidaat kan uitleggen hoe ecosystemen zich kunnen handhaven en ontwikkelen, en welke verstoringen daarbij kunnen plaatsvinden.

Subdomein E2: Ontstaan en handhaving van verscheidenheid

20. De kandidaat kan de betekenis van verscheidenheid in een populatie, onder andere op genniveau, aangeven, en opvattingen weergeven over het ontstaan daarvan.

Subdomein E3: Ethologie

21. De kandidaat heeft inzicht in de organisatie, ontwikkeling en functie van gedrag, en kent methoden die bij gedragsonderzoek gebruikt worden.

Appendix H

Text: CSE examquestions about current term E2
Source: www.slimslagen.nl / Noordhoff Uitgevers
Accessed: 23-11-2012 (problematic layout due to copying of paper-exam to pdf converted to word)

vwo – ontstaan en handhaving van verscheidenheid 2010

Lactasegen en evolutie

Bij mensen bevat chromosoom 1 het gen voor lactase. Het enzym lactase is nodig voor de omzetting van lactose, een suiker die in melk voorkomt. Bij de geboorte is het gen voor lactase in cellen van het verteringsstelsel geactiveerd, op latere leeftijd wordt het uitgeschakeld. Dat is ook begrijpelijk: melk drink je als baby en het zou zonde zijn van de energie om ook daarna nog dat enzym te blijven maken. Maar een paar duizend jaar geleden leerden men- sen de truc om de melk van gedomesticeerde dieren te drinken. Voor kinderen was dat prima, maar voor veel volwassenen bleek de lactose uit de melk niet te verteren. Zij kregen na het drinken van melk last van buikkrampen en diarree. Tegenwoordig kan meer dan 70% procent van de mensen van West-Europese herkomst hun hele leven lang probleemloos melk drinken en verteren, tegen minder dan 30% in delen van Afrika, Oost- en Zuidoost-Azië en Oceanië. Het percentage mensen dat lactose kan verteren verschilt van bevolkingsgroep tot bevolkingsgroep en van plaats tot plaats. Alle volken met een groot percentage melkdrinkers, zoals de Toearegs in de Sahara, de Bedoeïnen uit de Arabische woestijnen, de Ieren, de Tsjechen en Spanjaarden hebben een veehoudersverle- den met een lange geschiedenis van schapen-, geiten- of rundveehouderij.

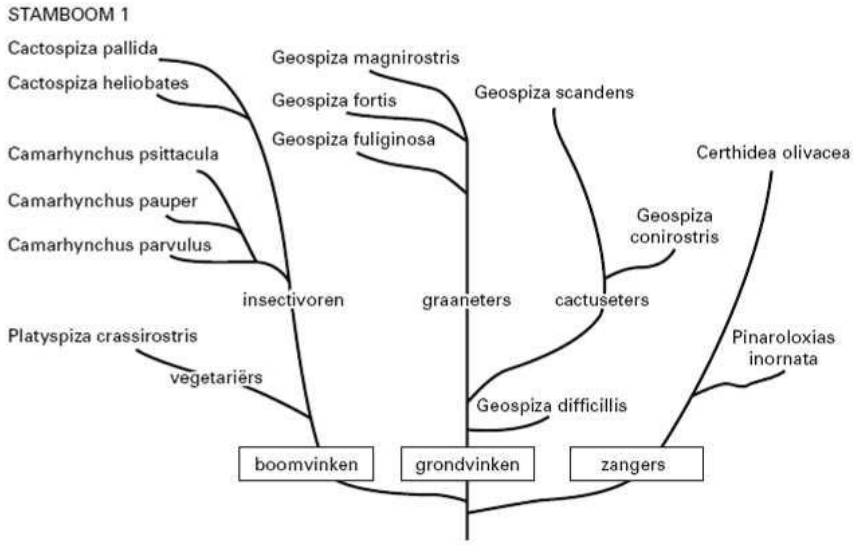
bewerkt naar: M. Ridley, Genoom, het recept voor een mens, Amsterdam/Antwerpen 1999, 170 e.v.

Het hoge percentage melkdrinkers in een bepaalde bevolkingsgroep kan worden verklaard met een evolutietheorie.Volgens de evolutietheorie die Darwin in de tweede helft van de negentiende eeuw formuleerde, ontstaan verschillen door erfelijke variatie en natuurlijke se- lectie. In willekeurige volgorde worden vijf beweringen gegeven.

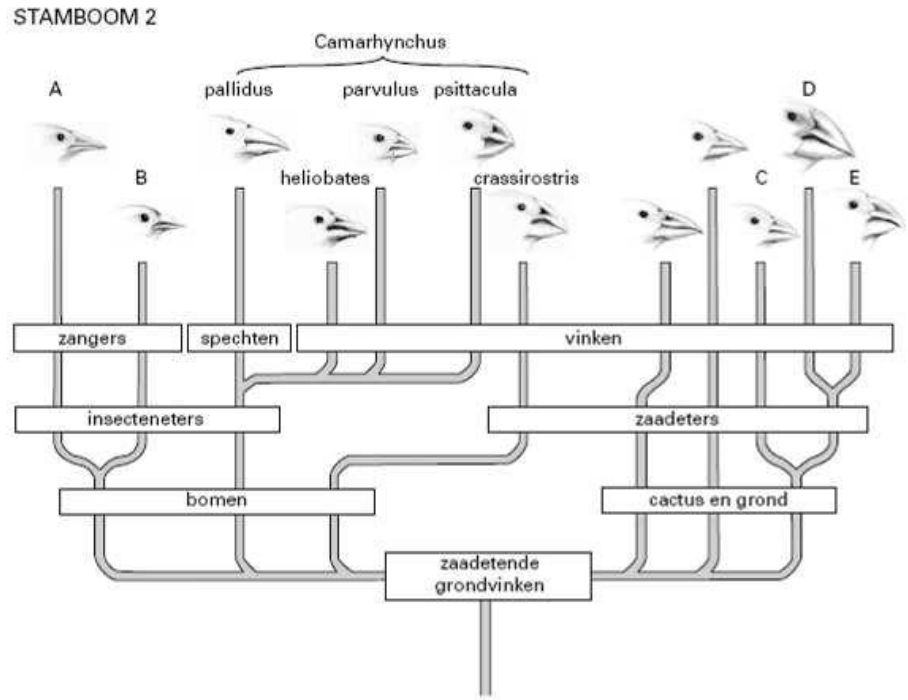
1 Door het voorbeeld van melkdrinkers te volgen, ontwikkelen alle volwasse- nen in de groep het vermogen lactose te verteren.
2 Door melk te drinken, ontwikkelt een volwassene gedurende zijn leven het vermogen om lactose te verteren.
3 Kinderen van mensen met het vermogen om als volwassene lactose te verte- ren, hebben een grote kans om als volwassene ook lactose te kunnen verte- ren.
4 Kinderen waarbij het lactasegen niet wordt uitgeschakeld, hebben een grote- re overlevingskans dan kinderen waarbij dat wel gebeurt.
5 Volwassenen die lactose kunnen verteren, bezitten een mutantgen dat zorgt dat het lactasegen niet uitgeschakeld wordt.

1p 1 Geef aan welke van deze beweringen aansluiten bij de huidige (neo-darwinis- tische) evolutietheorie. Schrijf alleen de nummers op.

Op de Galapagoseilanden komen vogelsoorten voor die nergens anders ter wereld voorkomen. Deze soorten stammen af van één gemeenschappelijke voorouder. Twee onderzoekers (1 en 2) hebben onafhankelijk van elkaar de afstamming van deze vogelsoorten bestudeerd. In onderstaande afbeelding zijn de resultaten van de twee studies weergegeven in de vorm van de stambomen 1 en 2. De namen die in stamboom 1 staan, zijn niet allemaal dezelfde als die in stamboom 2. Bovendien zijn in stamboom 2 enkele namen weggelaten.



bron: M. Ridley, Evolution, Blackwell Science, 1996, 571



bewerkt naar: David McFarland, Animal behaviour, Longman Scientific Technical, 1986, 6

Cactospiza pallida en Cactospiza heliobates in stamboom 1 zijn dezelfde vogels als respectievelijk Camarhynchus pallidus en Camarhynchus heliobates in stam- boom 2. De oorzaak hiervan kan zijn dat de onderzoekers niet dezelfde prioriteit hebben gegeven aan bepaalde indelingscriteria.

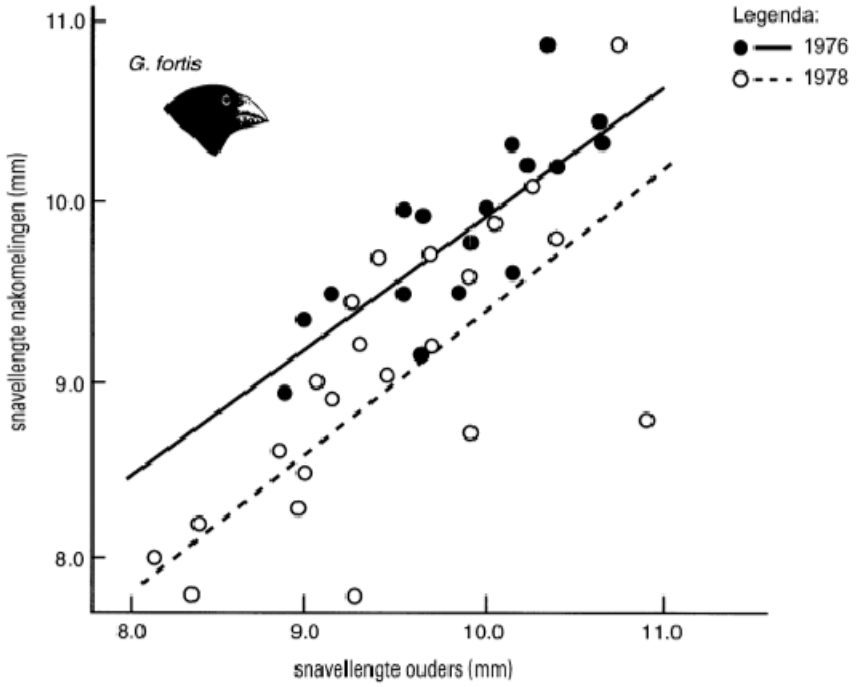
1p 2 Noem een andere mogelijke oorzaak waardoor het verschil in indeling van deze twee soorten door onderzoeker 1 en 2 verklaard kan worden.

In stamboom 2 zijn enkele soorten aangegeven met de letters A tot en met E.

2p 3 Op welke van deze plaatsen zou volgens stamboom 1 de soort Geospiza fuliginosa in stamboom 2 moeten staan, als bij de indeling binnen het genus (ge- slacht) Geospiza dezelfde criteria worden gebruikt als binnen stamboom 1?

A op plaats A
B op plaats B
C op plaats C
D op plaats D
E op plaats E

Onderzoekers menen dat de eigenschap snavellengte een criterium is voor na- tuurlijke selectie, mits de snavellengte een erfelijke eigenschap is. Onderzoek naar het al dan niet erfelijk zijn van de snavellengte bij Geospiza fortis leverde de resultaten op zoals die zijn weergegeven in onderstaand diagram.



bron: M. Ridley, Evolution, Blackwell Science, 1996, 223

Over deze twee grafieken worden de volgende beweringen gedaan:

1 De resultaten van dit onderzoek ondersteunen de hypothese dat de snavel- lengte een erfelijke eigenschap is, omdat er een verband is tussen de lengte van de snavels bij de jongen en de ouders;

2 Uit de resultaten van dit onderzoek kan men niet afleiden dat de snavellengte een erfelijke eigenschap is, omdat er slechts gegevens van twee jaren be- kend zijn.

2p 4 Welke van deze beweringen is juist?
A geen van beide beweringen
B alleen bewering 1
C alleen bewering 2

Pleksgewijze kaalheid

Pleksgewijze kaalheid wordt veroorzaakt door een autosomaal (niet X- chromosomaal) gen. Het gen voor pleksgewijze kaalheid is bij mannen dominant en bij vrouwen recessief. In een bepaalde populatie komt het gen voor pleksge- wijze kaalheid met een frequentie van 0,3 voor. Ga ervan uit dat het hebben van kale plekken op het hoofd geen invloed heeft op de partnerkeuze binnen deze populatie.
Neem aan dat in deze populatie de formule van Hardy-Weinberg toegepast kan worden.
2p 5 Bereken de frequenties van mannen met pleksgewijze kaalheid en van vrouwen met pleksgewijze kaalheid in deze populatie.

Ordening

Het biologische begrip soort kan op verschillende manieren worden gedefinieerd. Misschien is de meest bekende definitie wel die van de bioloog Ernst Mayr uit 1940: ”Soorten zijn groepen zich onderling voortplantende, natuurlijke popula- ties die reproductief geïsoleerd zijn van andere, dergelijke populaties”.
In dierentuinen zijn wel eens tijgers gekruist met leeuwen. Het bestaan van na- komelingen (teeuwen of lijgers) bewijst niet dat tijgers en leeuwen tot dezelfde soort behoren.
1p 6 Beargumenteer of deze bewering in overeenstemming is met de soort-definitie van Ernst Mayr.

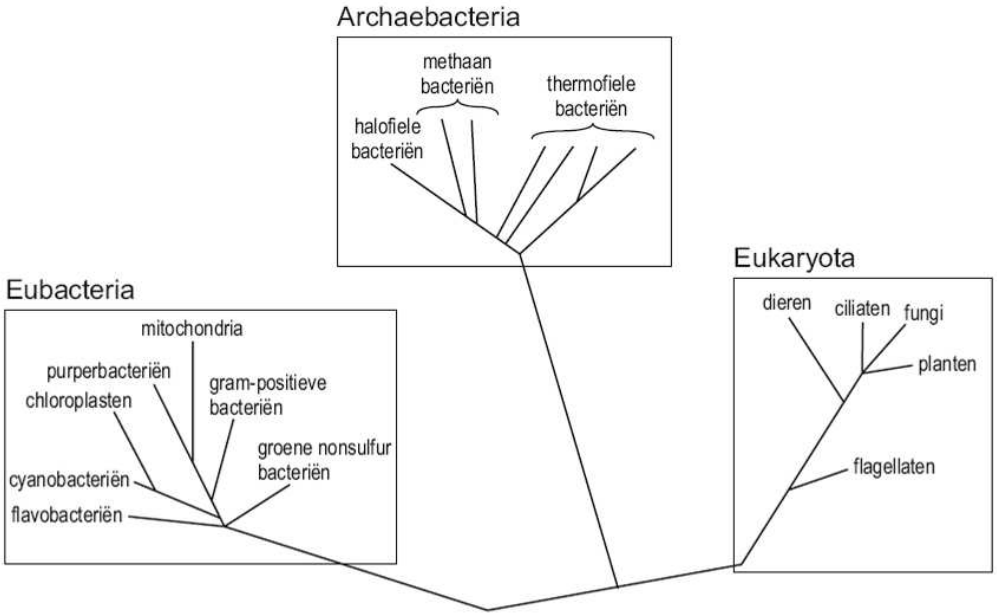
rRNA

De genetische overeenkomst van soorten kan mede worden bepaald op grond van de aminozuurvolgorde van bepaalde homologe eiwitten. Of andere macro- moleculen hiervoor geschikt zijn, hangt af van de diversiteit en de evolutionaire stabiliteit van deze macromoleculen. Ribosomaal RNA (rRNA) is voor dit doel ge- schikt.

2p 7
- Is rRNA geschikt doordat de moleculen een geringe of een grote diversi vertonen?
- Is rRNA geschikt doordat de moleculen een geringe of een grote evoluti stabiliteit hebben?

A door een geringe diversiteit en een geringe evolutionaire stabiliteit
B door een geringe diversiteit en een grote evolutionaire stabiliteit
C door een grote diversiteit en een geringe evolutionaire stabiliteit
D door een grote diversiteit en een grote evolutionaire stabiliteit

Organismen kunnen op grond van onder andere anatomische kenmerken worden ingedeeld in vier rijken. Op grond van rRNA-onderzoek worden organismen ook wel ingedeeld in drie domeinen: eubacteria, archaebacteria en eukaryota. In on- derstaande afbeelding is de indeling in deze domeinen weergegeven.



bewerkt naar: T.D. Brock en M.T. Madigan, Biology of microorganisms, Engle- wood, 1991, 688

Binnen de drie domeinen kun je bepaalde kenmerken vergelijken.
Hieronder is een tabel opgenomen met een aantal kenmerken.

domein	kernmem- braan*	wel of geen	celwand*	wel of geen	autotroof of heterotroof*	wel of geen	cellu- laire comparti- mentering*
Archaebacteria		geen		wel		beide	
Eubacteria							
Eukaryota							

* Vul in 'beide' als binnen het domein sommige organismen dit kenmerk wel hebben en andere organismen niet.

2p 8 Vul de tabel volledig in op grond van de gegevens in de afbeelding.

Cyanogene klaverplanten

Sommige planten zijn cyanogeen. Dat houdt in dat ze onder bepaalde omstan- digheden in hun bladeren en stengels de giftige stof blauwzuur of waterstofcya- nide (HCN) kunnen produceren. Blauwzuur verstoort de electronentransportke- ten. Door het blauwzuur zijn deze planten beschermd tegen vraat door bijvoor- beeld slakken. In cyanogene planten kan de volgende reactieketen plaatsvinden:

L-valine → → → → → → → → linamarine + H_2O → glucose + aceton + HCN

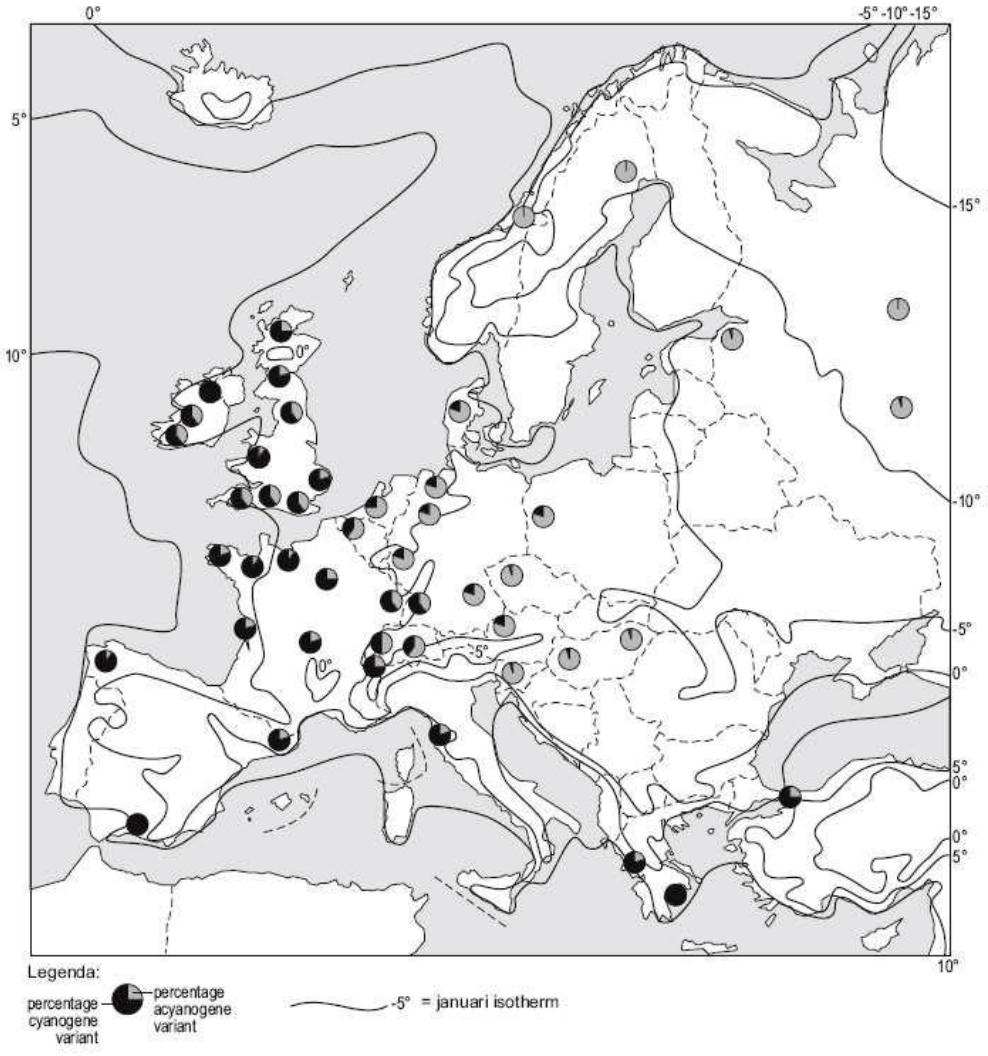
↑ (acht verschillende enzymen) ↑ (linamarase)

Van de plantensoort rolklaver (Lotus corniculatus) komen in Europa cyanogene en acyanogene varianten voor. De acyanogene planten kunnen geen blauwzuur vormen, doordat ze één van de bij de reactieketen betrokken enzymen missen. Bij de cyanogene klaverplanten bevindt linamarine zich in de vacuolen en het linamarase in de celwanden.

2p 9 - Leg uit dat de aanwezigheid van deze twee stoffen op verschillende plaatsen functioneel is voor de plant zelf.

- Leg uit dat dit mechanisme van belang is voor instandhouding van de plan- tensoort.

In onderstaande afbeelding is de verspreiding van de cyanoge en acyanogene rolklaverplanten over Europa weergegeven.



bewerkt naar: Jos Verkleij, Cyanogenese bij planten, conferentie 'Van gen naar ecosystemen', VU Amsterdam, oktober 2003

In de sectordiagrammen zijn de percentages van de cyanogene variant (zwart) en van de acyanogene variant (grijs) in de desbetreffende gebieden aangegeven. De lijnen geven een aantal januari-isothermen aan.

3p 10 - Geef een verklaring voor het ontstaan van deze twee varianten van rolklaver.

- Geef met behulp van de gegevens in de tekst en de afbeelding een verklaring voor het verschil in de verspreiding van de cyanogene en de acyanogene va- riant.

Kleurenblindheid

Het eiland Pingelap in de Stille Oceaan heeft ongeveer 800 bewoners. Van de bewoners is 8% volledig kleurenblind doordat ze geen kegeltjes hebben. Op de plaatsen waar bij kleurenzienden kegeltjes voorkomen, bevinden zich bij deze kleurenblinden geen lichtreceptoren. Deze vorm van kleurenblindheid komt elders in de wereld bij 1 op de 30.000 mensen voor. Het gen voor deze vorm van kleurenblindheid is recessief en autosomaal (niet X-chromosomaal).

3p 11 Bereken hoeveel maal groter de frequentie van dit gen voor kleurenblindheid op het eiland Pingelap is dan de frequentie van dit gen in de rest van de wereld. Rond je antwoord af op een geheel getal.

De afstand tussen Pingelap en het dichtstbij gelegen eiland is zo'n 280 kilometer. Door de eeuwen heen is er niet veel contact geweest met bewoners van andere eilanden. Pingelap werd omstreeks 1775 getroffen door een wervelstorm, waarbij vrijwel de gehele bevolking omkwam. Zo'n twintig mensen overleefden de ramp. Rond 1820 werden de eerste kleurenblinde kinderen geboren. Het percentage kleurenblinden is al een aantal generaties stabiel.

bewerkt naar: O. Sacks, Het eiland der kleurenblinden, Amsterdam, 1996, 66

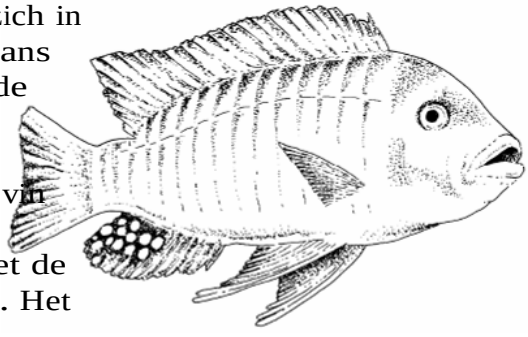
Onder de nakomelingen van de mensen die de natuurramp op Pingelap overleef- den, komt de hierboven beschreven vorm van kleurenblindheid veel voor.

3p 12 - Waardoor is de frequentie van het gen voor kleurenblindheid bij de bewoners meteen na de ramp hoger dan ervoor?

- Noem twee factoren waardoor de frequentie hoog is gebleven.

Eivlekken

Bij bepaalde vissoorten, zoals de zebracich- lide Pseudotropheus zebra, ontwikkelen de eieren zich in de bek van het vrouwtje. Tij- dens de paringsdans neemt het vrouwtje de door haar geproduceerde eieren in haar bek. Vervolgens spreidt het mannetje zijn anale vin en produceert sperma. Op zijn anale vin bevindt zich een aantal opvallende geel-oranje vlekken die een sterke gelijke- nis vertonen met de eieren. Dit is te zien in de afbeelding hiernaast. Het vrouwtje hapt



naar de 'eivlekken' op de vin waarbij een deel van het geproduceerde sperma wordt opgehapt. Door dit gedrag is de kans op bevruchting van de eieren groot.

Sommige biologen menen dat deze eivlekken in de loop van de evolutie ontstaan zijn uit kleine parelvormige vlekjes die bij veel soorten cichliden voorkomen.

3p 13 Leg uit op welke wijze cichlidesoorten met eivlekken volgens deze biologen zijn ontstaan.

Andere onderzoekers trekken deze veronderstelde functie van de eivlekken in twijfel. Zij staan sceptisch tegenover de gesuggereerde evolutionaire ontwikke- ling vanwege het ontbreken van een precieze overeenkomst in kleur, vorm en afmeting van eieren en eivlekken. Deze tegenstanders zijn van mening dat de vlekken op de anale vin vooral een herkenningsfunctie hebben: het soort- specifieke vlekkenpatroon stelt volgens hen een vrouwtje in staat een partner van de eigen soort te herkennen.

Verschillende onderzoeken naar de betekenis van de eivlekken hebben onder meer de volgende resultaten opgeleverd:

1 soorten waarvan de eivlekken duidelijk groter en opvallender zijn dan de eie- ren, baltsen merendeels in dieper water waar het zicht geringer is;

2 bij soorten met eivlekken die weinig gelijkenis vertonen met de eieren, hapt het vrouwtje tijdens de balts in dezelfde mate naar de anale vin als bij soor- ten met goed gelijkende eivlekken;

3 het verwijderen van de eivlekken van de anale vin heeft geen invloed op de mate waarin het vrouwtje tijdens de balts naar de anale vin hapt.

2p 14 Welk van de genoemde onderzoeksresultaten ondersteunt of welke ondersteunen de mening dat de vlekken op de anale vin vooral een soortspecifieke herken- ningsfunctie hebben?

A alleen resultaat 1
B alleen resultaat 2
C alleen resultaat 3
D alleen de resultaten 1 en 2
E alleen de resultaten 1 en 3
F de resultaten 1, 2 en 3

Schapen

Bij schapen komt een witte vacht tot stand onder invloed van het dominante gen H en een zwarte vacht door het recessieve gen h. Uit een kudde schapen in Ida- ho (V.S.) werd een steekproef van 900 schapen genomen. Van deze schapen hadden er 891 een witte en 9 een zwarte vacht. Op deze populatie is de regel van Hardy-Weinberg van toepassing.

2p 15 Bereken de frequentie van gen H in deze populatie.

Ziekte van Gaucher

De ziekte van Gaucher is een erfelijke stofwisselingsziekte die wordt veroorzaakt door een recessief autosomaal gen. Door het ontbreken van een bepaald enzym, glucocerebrosidase, vindt stapeling van (afval)stoffen plaats in de organellen

waarin deze stoffen bij een gezonde persoon door het enzym worden omgezet. Deze stapeling is giftig voor de cel en veroorzaakt ten slotte schade in weefsels en organen.
In een bepaalde populatie is één op de 200 personen heterozygoot voor de ziek- te van Gaucher. Een man en een vrouw uit deze populatie krijgen samen een kind. Zij weten niet of zij drager zijn van het gen voor deze ziekte. Gesteld wordt dat dragers van het gen voor de ziekte dezelfde voortplantingskansen hebben als niet-dragers.
2p 16 - Bereken de kans dat hun kind deze ziekte heeft.
- Geef je antwoord in procenten met vier decimalen.

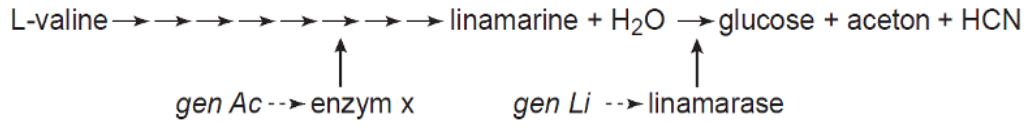
Polydactylie

In een bepaalde, geïsoleerde groep mensen komen individuen voor met meer dan tien vingers en/of tenen. Deze afwijking heet polydactylie. De afwijking wordt veroorzaakt door een dominant gen L. Een student onderzoekt 896 men- sen uit deze groep. 220 mensen daarvan hebben een normaal aantal vingers en tenen. De student neemt aan dat deze groep van 896 mensen beschouwd kan worden als een populatie die voldoet aan de Hardy-Weinberg-regel.
2p 17 Bereken op basis van deze gegevens de frequentie van het gen L in deze populatie.

De student had verwacht in die populatie meer mensen met polydactylie aan te treffen. Hij had namelijk in de resultaten van een vorig onderzoek gelezen dat de frequentie van het gen L in die populatie 0,75 is.
1p 18 Geef een mogelijke verklaring voor het feit dat in het onderzoek van de student een lagere frequentie van het gen L dan in het vorige onderzoek is gevonden.

Planten verdedigen zich

Sommige planten, waaronder exemplaren van de vlinderbloemige soorten Witte klaver (Trifolium repens) en Rolklaver (Lotus corniculatus), zijn bestand tegen vraat door slakken, veldmuizen en insecten door de productie van de giftige stof blauwzuur (HCN). Zij worden 'cyanogene' planten genoemd.
Verschillende genen zijn betrokken bij verschillende stappen in de productie van HCN. Het gen Ac codeert voor de vorming van enzym x, het gen Li voor de vor- ming van linamarase.
In de afbeelding zijn de vereenvoudigde reactieketen en enkele factoren die daarop van invloed zijn, schematisch weergegeven.



Uit een weiland in het Amsterdamse bos werden exemplaren van witte klaver verzameld en getest op de aanwezigheid van het enzym x en van het enzym li- namarase. Het resultaat is in de volgende tabel gegeven.

enzymen in plant	aantal planten
beide enzymen	8
alleen enzym x	24
alleen linamarase	14
geen van beide enzymen	47

2p 19 Wanneer mag de regel van Hardy-Weinberg worden toegepast om aan de hand van dergelijke gegevens de frequenties van de allelen Ac en ac en van Li en li in deze populatie witte klaverplanten te berekenen? Noem drie van de voorwaarden waaraan moet worden voldaan.

Neem aan dat de regel van Hardy-Weinberg toegepast mag worden.

2p 20 Wat zijn de frequenties van het dominante allel Ac en het dominante allel Li in deze populatie witte klaverplanten?

	Ac	Li
A	0,19	0,13
B	0,19	0,81
C	0,51	0,39
D	0,51	0,81
E	0,81	0,87
F	0,87	0,13

Appendix I

Text: WEB terms overview, 1994
Source: Mierlo, 2004. Chapter 9
Accessed 26-11-2012

1994 (SLO)

LEERPLAN BIJ HET NIEUWE EXAMENPROGRAMMA VAN DE WEB

Project Biologie Bovenbouw, SLO, Enschede, mei 1994. Auteurs drs. J.M. Kapteijn,

Drs. J. Morélis, m.m.v. Drs. E.X. Maier,

p. 14-16.

De verdeling van de leerstof over alle onderdelen is als volgt:

1. Diversiteit in ecosystemen

ecosystemen; biotische en abiotische factoren; soort en populatie; vier rijken; beïnvloeding groei en voortplanting bij zaadplanten; functie van stengel, wortel, blad en zaden

2. Cellen: bouw en functie

bouw en functie van cellen; verschil plantaardige en dierlijke cellen; L.M. en E.M. afbeeldingen; cellen maken deel uit van weefsels en organen; mitose/plasmagroe (herstel, vervanging, groei); erfelijke info in DNA; weefselkweek; turgor, osmose, diffusie, actief transport;

3. Voeding

planten als voedselbron en basis voor geneesmiddelen; invloed voeding op groei e ontwikkeling; relatie voeding en gezondheid; bouw verteringsorganen; functie en werking verteringsorganen

4. Celstofwisseling

assimilatie en dissimilatie; aerobe/anaerobe dissimilatie; fotosynthese voortgezette assimilatie; functie van stofwisselingsprodukten; gebruik van gist en bacterien;

5. Gaswisseling

bouw longen en luchtwegen; functie longen en luchtwegen; regeling ventilatie relatie leefwijze en gezondheid;

6. Transport

bouw hart en bloedvaten; lymfevaten; functie hart en bloedvaten; bestanddelen bloed: vorming en functie; transport haarvaten ~ cellen;

7. Uitscheiding

bouw nieren en urinewegen; functie en werking nieren; bouw lever; functie lever;

8. Sexualiteit en voortplanting

voortplanting, groei, ontwikkeling van de mens; betekenis sexualiteit; verstoorde embryonale ontwikkeling; SOA's

9. Verschillen tussen mensen

genotype/fenotype karyogrammen en erfelijkheidsonderzoek meiose/chromosoom/chromatide/gen; mutatie

1O. Erfelijkheid

doorgeven van erfelijke informatie en toepassingen daarvan: mono- en dihybride kruisingen, stamboomonderzoek, ABO-stelsel; bloedgroepen, modificatie; veredele en fokken, klonen, genetische manipulatie; DNA en erfelijke informatie

11. Gedrag

inwendige en uitwendige factoren: handelingen, erfelijke factoren, abiotische factoren, leerprocessen; functie sociaal gedrag en communicatie: taakverdeling, coordinatie, rolpatronen, normen en waarden

12. Energiestromen en kringlopen in ecosystemen

energiestromen en kringlopen: fotosynthese, biomassa, voedselketen, kringlopen, producenten, consumenten, reducenten; invloeden van mens op ecosystemen: toevoeging/onttrekking van elementen, beheers- en beleidsmaatregelen i.v.m. afval gebruik van zaadplanten door de mens: hout, fossiele brandstoffen

13. Successie en evolutie

handhaving ontwikkeling verstoring van ecosystemen; variatie/selectie/evolutietheorie; invloed van mens op ecosystemen; verandering van elementen, beheer en beleid i.v.m. ruimtelijke ordening

14. Waarmeming, houding en beweging

relatie prikkel en impuls; soorten zintuigen en hun ligging bouw, functie, werking oog; bouw en functie zenuwstelsel; reflex; bouw, functie, werking spieren;

15. Hormonen/regeling

regulering, negatieve terugkoppeling; autonome zenuwstelsel;

16. Bescherming/ziekte en gezondheid

bouw en functie van de huid; antistoffen, antigenen; immunisatie; ABO/resus en bloedtransfusie; eindigheid van het leven; ontregelde groei/kankercellen

17. Herhaling

Belangrijke concepten herhalen; Verbanden leggen; Systematisch aanpakken van problemen; Examentraining.