I WANT TO LIVE FOREVER...

1. INTRODUCTION

People grow old, and eventually die. This fact seems so obvious that we rarely ever think about it. But why do some people live to be 89, and others only 52? And why do we grow old anyway? Why don't we just live forever? What must we do not only to live a long life, but also a long and healthy one? In different places around the world, scientists are busy searching for answers to these questions. Over the next few lessons you will see that this search involves a lot of biology, and encompasses an enormous range of different topics – wrinkles, stress, evolution, cell division, and sex. But although very diverse, these subjects all have something to do with the biology of ageing.

Have fun!

Caspar Geraedts, Jennifer Verkleij & Yuri Matteman

De Praktijk

De Praktijk, 2010. These learning materials are subject to the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Netherlands License. Go to http://creativecommons.org/licenses/by-nc-nd/3.0/nl/ for further information. *This material has been funded by the EU Network of Excellence LifeSpan.*

Assignment 1. We are living longer and longer...

People are living longer and longer – over the past two centuries, our average life expectancy has risen significantly. The graph below shows the average life expectancy of women from eight different countries.

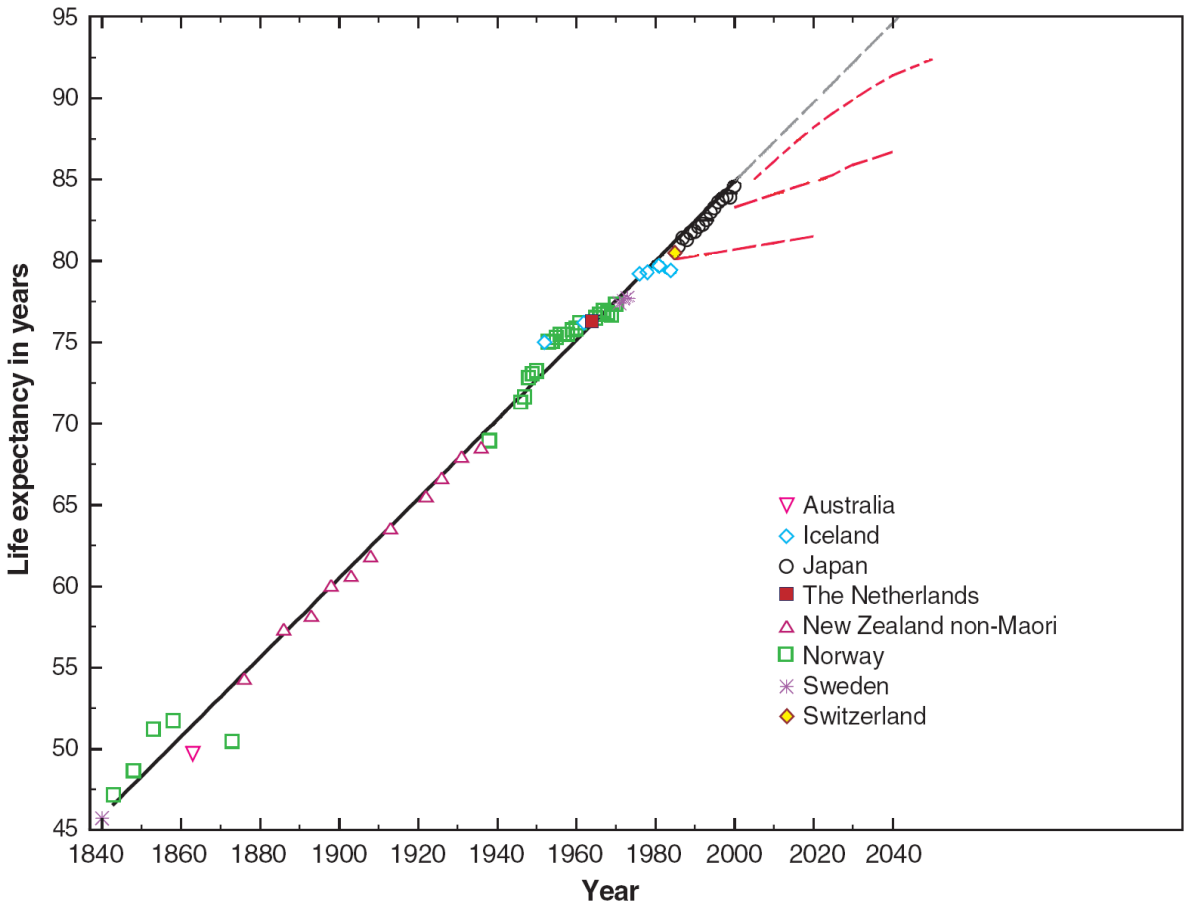


Figure 1. The average life expectancy of women from eight different countries, from 1840 until today. We see a linear increase (the black line that turns into the grey dotted line). From: Oeppen & Vaupel (2002).

1. There are various factors that have influenced the increase in average life expectancy. Place the following factors in chronological order (simply note the letters).

A. Blood vessels that have become clogged can be 'cleaned out' via angioplasty.
B. The discovery of penicillin (an antibiotic).
C. The black rat (spreader of diseases such as the plague) is supplanted by the brown rat.
D. Vaccines (e.g. against smallpox) are employed on a large scale.
E. Many houses in large cities are connected to a (closed) sewage system.

EARLIER. . . . . NOW

2. Look at the list of eight countries (in Figure 1). Which selection criteria do you think the researchers used? Why?

.....

.....

The dotted lines that curve away from the straight line at the top right show the predictions made by the United Nations in 1986, 1999 and 2001 (from bottom to top). These predictions assume the existence of a certain limit (i.e. a maximum possible life expectancy), and that the average life expectancy will not increase much further beyond a certain point.

3. Does the graph suggest that such a limit does or does not exist? Explain your answer.

.....

.....

According to the graph, our average life expectancy increases by approximately 3 months per year. If we assume that average life expectancy will continue to increase in a linear fashion, we can estimate it's progress using the following formula:

$$y = 0.25\,x - 415.5$$

where life expectancy (y) is a function of the year (x).

4. Use this formula to calculate the average life expectancy for the years 2100 and 2500.

average life expectancy in 2100: .....

average life expectancy in 2500: .....

(What does this mean for your own life expectancy?)

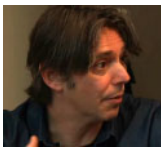
5. Some scientists predict that it will not be too long before people will be able to live for 1000 years. Give one reason why you would like to live to be 1000, and also think of a reason why you would not like to live that long.

yes, because .....

no, because .....

Assignment 2. The LifeSpan research project

You are about to watch a video in which scientists discuss the research that they are conducting on ageing. The list below outlines what each of these scientists is researching.

	David Gems, England	studies the link between genes, gene expression and life expectancy in nematodes (small worms)
	Andres Metspalu, Estonia	studies the link between life expectancy and certain genetic markers in human DNA (using large datasets, or biobanks)
	Evelyna Derhovanessian, Germany	studies the changes that occur in the human immune system late in life
	Daryl Shanley, England	studies the mechanisms of cellular repair using computer models
	Laurent Keller, Switzerland	studies the link between gene expression, phenotypes and life expectancy in ants
	Ron de Kloet, The Netherlands	studies the influence of stress during childhood on functioning later in life (in rats and humans)

1. Watch the video titled 'SENEX'.

The six scientists in the film collaborate closely with one another. A hundred years ago it was much less common for scientists from different universities to work together on a single research project. Nowadays, it is very normal.

2. What (very practical) reason can you think of to explain this?

. . . . . .

. . . . . .

The underlying purpose of the LifeSpan research project is to gain a better understanding of how the ageing process works in humans, and how it is influenced by events early in our lives. It is for this reason that Andres Metspalu, Evelyna Derhovanessian and Ron de Kloet conduct research using *human test subjects*. However, two researchers in the video – David Gems and Laurent Keller – conduct research using what are called *model organisms* (in this case, roundworms and ants). Daryl Shanley uses *computer models*.

3. Each research method has its own advantages and disadvantages. Which from the list below apply to which methods? Write the letters in the table.

A. There are large differences between different species of animals.
B. Genetic manipulation is permitted (within certain limits).
C. It is a simplification of reality.
D. You can artificially make time pass much faster.
E. This way we learn things directly about ourselves.
F. They must not die as a result of the research.

	advantage	disadvantage
human test subjects		
model organisms		
computer models		

Assignment 3. Game: *I want to make babies!*

What is ageing exactly? There are three important concepts involved in answering this question: damage, maintenance and reproduction.

Ageing is the accumulation of damage

Ageing is the result of the cumulative damage that we suffer over the course of our lives. This begins as early as our birth. Although most kinds of damage are only very minor, the sum total of all the molecular damage (or the scars left behind as a result) means that our bodies deteriorate slowly but surely, and that we eventually die.

Organisms invest in maintenance and reproduction

Fortunately, we are able to wholly or partially repair many kinds of damage. But: repairs cost energy. There are hardly any organisms that invest all of their energy in maintenance (i.e. repairing damage). Another important goal for organisms is reproduction, or in other words, sex. It is true that there are organisms that can reproduce asexually. However, a balance is always struck between investing in repairing damage ('long life') and investing in reproduction ('lots of babies').

1. Form a group of four students.

2. Your teacher will give you a copy of the game *I want to make babies!* Play the game.

- Each person receives two counters: a damage counter and a sex counter.
- The aim of the game is to have as many babies as possible whilst also becoming at least 80 years old.
- Have children by passing by the red arrow as many times as possible with your sex counter.
- You grow older by remaining in the game for as long as possible – every turn you age 10 years.
- However, every turn you also receive a card containing a number of damage points. Advance your damage counter by this many points. Once you have reached 70 (or more) damage points, you are out of the game and may no longer spend any more energy points.
- Note: the damage points therefore do NOT represent your age, but only give an indication of your health and physical condition. Your age is determined by the number of turns taken (count the cards).
- Each turn you may spend a total of 7 energy points, divided between reproduction (advancing your sex counter) and repairing damage (moving your damage counter backwards). You may decide yourself how many steps you take with each counter, as long as you make 7 in total.
- The game is over once all players have reached 70 damage points. The player who is at least 80 years old and has the most children is the winner.

3. Note all of the players' scores at the end of the game.

player's name	age reached (= no. of damage cards x 10)	no. of children
1.		
2.		
3.		
4.		

4. Nature displays major differences in life expectancy. There are short-lived species, such as rats (max. 4 years) as well as long-lived species, such as pigeons (max. 35 years). Research has shown that one of these two species invests more energy in protecting its cells against damage (in this case, oxidative stress). Which of the two will this be? Explain your answer.

.....

.....

5. Rats and pigeons also exhibit a difference in the number of offspring per litter/nest. Which of these two animals will produce more offspring at a time?

.....

.....