1. **Discussion**
   - Are you scared of getting old?
   - Are you worried about reaching your 50s?
   - Does the ageing process frighten you?
   - At what age do you consider a person to be old?
   - Is it difficult to cope with growing old?
     The 38-year-old Uma Thurman confessed: "You know, I was scared of being 25, then of being 35 and at present I'm afraid of being 55. Time doesn't frighten me as much as it used to a few years ago."
   - What is ageing?
   - What are the effects of ageing?
   - Can ageing be "cured"?
   - What are the physical limitations of older people?

2. **Watch the video "Age suit" and answer the questions**
   Why was the special suit invented?
   What are the physical limitations of older people mentioned in the video clip? Tick them off.

feel stiff	*muscle strength decreases*
reduction in joint mobility	*changes in our spine*
declining cognitive abilities	*changes in our eyesight*
reduction in our tactile senses	*weaker bones*
reduction in balance	

http://www.boston.com/business/technology/articles/2009/03/23/at_mits_agelab_growing_old_is_the_new_frontier/?page=2)

3. **What is it senescence? Complete the text with the correct form of the words in brackets.**

   In biology, senescence is the state or process of (age) _____.
   (Cell) _____ senescence is a phenomenon where isolated cells demonstrate a (limit) _____ ability to divide in culture (the Hayflick Limit, discovered by Leonard Hayflick in 1961), while organismal senescence is the ageing of organisms.
   After a period of near perfect (renew) _____ (in humans, between 20 and 35 years of age), organismal senescence (characterize) _____ by the declining ability to respond to stress, increasing homeostatic imbalance and increased risk of disease.
   This irreversible series of changes (inevitable) _____ ends in death.

http://en.wikipedia.org/wiki/Ageing#Senescence

4. **Revision: complete the text then listen to the recording and check** (timing 1:04-1:55)

   The human body is made up of many _____ which are made from many types of _____ These _____ are made of individual units called _____. Each of these _____ contains 46 _____ 23 inherited from each of your parents. _____ contain segments that are called _____. Each _____ contains specific information that makes us unique. The _____ is made of _____ through a set of complex instructions. _____ directs the body to make _____ They are used to make and run our body _____.

http://www4.utsouthwestern.edu/cellbio/shay-wright/intro/sw_intro.html

5. Check the pronunciation

telomere	/'tɛlə,mɪər, 'tilə-/	chromosome	/'kroʊmə,soʊm/
	The segment of DNA that occurs at the ends of chromosomes.		
enzyme	/'ɛnzaɪm/	apoptosis	/āp'əp-tō'sĭs, āp'ə-tō'-/
telomerase	/tə'lɒmə,reɪs; -,reɪz/	senescent	/sɪ'nɛsənt/
protein	/'proʊtin; -tiɪn/	senescence	/sĭ-nĕs'əns/
inhibit	/ɪn'hɪbɪt/	arteriosclerosis	/ɑr,tɪəriːoʊsklə'roʊsɪs/
ulcer	/'ʌlsər/	plaque	/plæk/
template	/'tɛmplɪt/		

6. True or False?

a. Telomere is the segment of DNA that occurs at the ends of chromosomes.

b. In reproductive cells the telomere shortens occasionally.

c. Telomeres function by helping chromosomes to lose base pair sequences at their ends.

d. Each time a cell divides, some of the telomere is lost.

e. When the telomere becomes too long, the chromosome reaches a "critical length" and can no longer replicate.

f. Telomerase is an enzyme that causes telomeres to lengthen, facilitates cell division and may account for the mortality of cancer cells.

g. Telomerase activity is regulated during development and has a very low, almost undetectable activity in somatic (body) cells. Because these somatic cells do not regularly use telomerase, they age.

h. If telomerase is activated in a cell, the cell will continue to grow and divide.

i. Telomerase – enzyme works in harmony with the telomere clock in the cell.

7. Watch the video and check your answers. (timing 1:55–5:08; 6:00-6:54)

http://www4.utsouthwestern.edu/cellbio/shay-wright/intro/sw_intro.html

	Any of numerous proteins or conjugated proteins produced by living organisms and functioning as specialized catalysts for biochemical reactions.
	An enzyme, active chiefly in tumors and reproductive cells, that causes telomeres to lengthen, facilitates cell division and may account for the immortality of cancer cells.
	A threadlike linear strand of DNA and associated proteins in the nucleus of eukaryotic cells that carries the genes and functions in the transmission of hereditary information.
	The process by which a cell dies at a natural, "pre-programmed" time.
	The process of cellular aging.
	A strand of DNA or RNA that serves as a pattern for the synthesis of a complementary strand of nucleic acid or protein.

8. What do the definitions mean?

9. <u>Homework</u>

a. **Watch the rest of the video and be ready to report on the potential applications of current telomerase research?**

b. **Study the information about the Nobel Prize in Physiology or Medicine 2009.**
Who are the Nobel Laureates?
What have they been awarded for? Explain their contribution in your own words.

c. **Ask about the underlined fragements in the text. Formulate the question so that you can answer with the underlined expressions.**

10. Ask about the underlined fragements in the text. Formulate the question so that you can answer with the underlined expressions

The Nobel Assembly at Karolinska Institutet has decided to award
The Nobel Prize in Physiology or Medicine 2009 jointly to

Elizabeth H. Blackburn, Carol W. Greider and Jack W. Szostak or the discovery of
"how chromosomes are protected by telomeres and the enzyme telomerase"

Summary

1_____

This year's Nobel Prize in Physiology or Medicine is awarded to three scientists who have solved a major problem in biology: how the chromosomes can be copied in a complete way during cell divisions and how they are protected against degradation. The Nobel Laureates have shown that the solution is to be found in the ends of the chromosomes – the telomeres – and in an enzyme that forms them – telomerase.

2_____

The long, thread-like DNA molecules that carry our genes are packed into chromosomes, the telomeres being the caps on their ends. Elizabeth Blackburn and Jack Szostak discovered that a unique DNA sequence in the telomeres protects the chromosomes from degradation. Carol Greider and Elizabeth Blackburn identified telomerase, the enzyme that makes telomere DNA. These discoveries explained how the ends of the chromosomes are protected by the telomeres and that they are built by telomerase.

3_____

If the telomeres are shortened, cells age. Conversely, if telomerase activity is high, telomere length is maintained, and cellular senescence is delayed. This is the case in cancer cells, which can be considered to have eternal life. Certain inherited diseases, in contrast, are characterized by a defective telomerase, resulting in damaged cells. The award of the Nobel Prize recognizes the discovery of a fundamental mechanism in the cell, a discovery that has stimulated the development of new therapeutic strategies.

4_____

The mysterious telomere

The chromosomes contain our genome in their DNA molecules. As early as the 1930s, Hermann Muller (Nobel Prize 1946) and Barbara McClintock (Nobel Prize 1983) had observed that the structures at the ends of the chromosomes, the so-called telomeres, seemed to prevent the chromosomes from attaching to each other. They suspected that the telomeres could have a protective role, but how they operate remained an enigma.

5_____

When scientists began to understand how genes are copied, in the 1950s, another problem presented itself. When a cell is about to divide, the DNA molecules, which contain the four bases that form the genetic code, are copied, base by base, by DNA polymerase enzymes. However, for one of the two DNA strands, a problem exists in that the very end of the strand cannot be copied. Therefore, the chromosomes should be shortened every time a cell divides – but in fact that is not usually the case (Fig 1).

6_____

Both these problems were solved when this year's Nobel Laureates discovered how the telomere functions and found the enzyme that copies it.

7_____

Telomere DNA protects the chromosomes

In the early phase of her research career, Elizabeth Blackburn mapped DNA sequences. When studying the chromosomes of *Tetrahymena*, a unicellular ciliate organism, she identified a DNA sequence that was repeated several times at the ends of the chromosomes. The function of this sequence, CCCCAA, was unclear. At the same time, Jack Szostak had made the observation that a linear DNA molecule, a type of minichromosome, is rapidly degraded when introduced into yeast cells.

8_____

Blackburn presented her results at a conference in 1980. They caught Jack Szostak's interest and he and Blackburn decided to perform an experiment that would cross the boundaries between very distant species (Fig 2). From the DNA of *Tetrahymena*, Blackburn isolated the CCCCAA sequence. Szostak coupled it to the minichromosomes and put them back into yeast cells. The results, which were published in 1982, were striking – the telomere DNA sequence protected the minichromosomes from degradation. As telomere DNA from one organism, *Tetrahymena*, protected chromosomes in an entirely different one, yeast, this demonstrated the existence of a previously unrecognized fundamental mechanism. Later on, it became evident that telomere DNA with its characteristic sequence is present in most plants and animals, from amoeba to man.

9_____

An enzyme that builds telomeres

Carol Greider, then a graduate student, and her supervisor Blackburn started to investigate if the formation of telomere DNA could be due to an unknown enzyme. On Christmas Day, 1984, Greider discovered signs of enzymatic activity in a cell extract. Greider and Blackburn named the enzyme telomerase, purified it, and showed that it consists of RNA as well as protein (Fig 3). The RNA component turned out to contain the CCCCAA sequence. It serves as the template when the telomere is built, while the protein component is required for the construction work, i.e. the enzymatic activity. Telomerase extends telomere DNA, providing a platform that enables DNA polymerases to copy the entire length of the chromosome without missing the very end portion.

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Telomeres delay ageing of the cell

Scientists now began to investigate what roles the telomere might play in the cell. Szostak's group identified yeast cells with mutations that led to a gradual shortening of the telomeres. Such cells grew poorly and eventually stopped dividing. Blackburn and her co-workers made mutations in the RNA of the telomerase and observed similar effects in *Tetrahymena.* In both cases, this led to premature cellular ageing – senescence.

In contrast, functional telomeres instead prevent chromosomal damage and delay cellular senescence. Later on, Greider's group showed that the senescence of human cells is also delayed by telomerase. Research in this area has been intense and it is now known that the DNA sequence in the telomere attracts proteins that form a protective cap around the fragile ends of the DNA strands.

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An important piece in the puzzle – human ageing, cancer, and stem cells

These discoveries had a major impact within the scientific community. Many scientists speculated that telomere shortening could be the reason for ageing, not only in the individual cells but also in the organism as a whole. But the ageing process has turned out to be complex and it is now thought to depend on several different factors, the telomere being one of them. Research in this area remains intense.

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Most normal cells do not divide frequently, therefore their chromosomes are not at risk of shortening and they do not require high telomerase activity. In contrast, cancer cells have the ability to divide infinitely and yet preserve their telomeres. How do they escape cellular senescence? One explanation became apparent with the finding that cancer cells often have increased telomerase activity. It was therefore proposed that cancer might be treated by eradicating telomerase. Several studies are underway in this area, including clinical trials evaluating vaccines directed against cells with elevated telomerase activity.

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Some inherited diseases are now known to be caused by telomerase defects, including certain forms of congenital aplastic anemia, in which insufficient cell divisions in the stem cells of the bone marrow lead to severe anemia. Certain inherited diseases of the skin and the lungs are also caused by telomerase defects.

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In conclusion, the discoveries by Blackburn, Greider and Szostak have added a new dimension to our understanding of the cell, shed light on disease mechanisms, and stimulated the development of potential new therapies.

Based on: http://nobelprize.org/nobel_prizes/medicine/laureates/2009/press.html Accessed: Oct.9, 2009