

MEIOSIS

13 FEBRUARY 2013

Lesson Description

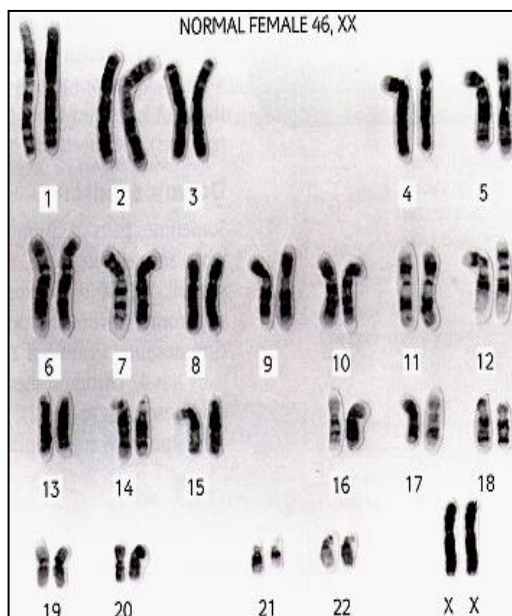
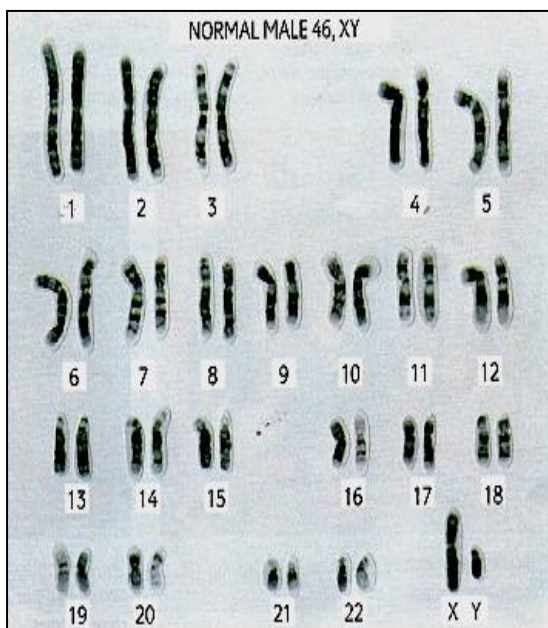
In this lesson, we will discuss:

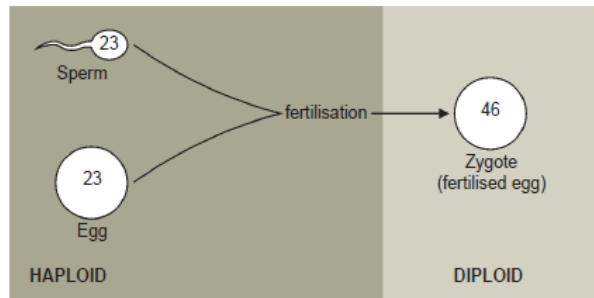
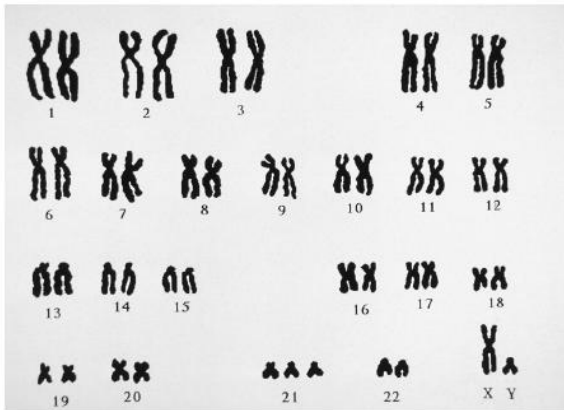
- First division (meiosis 1) - Prophase 1, Metaphase 1, Anaphase 1, Telophase 1
- Second division (meiosis 2) – Prophase 2, Metaphase 2, Anaphase 2, Telophase 2
- The importance of meiosis
- The consequences of abnormal meiosis leading to Down's Syndrome and Polyploidy
- A comparison of Mitosis & Meiosis

Key Concepts

Terminology:

- **Cell division** - process by which cells reproduce – mitosis & meiosis
- **Chromosomes** - cell parts that determine what traits a living thing will have
- **Chromatid** - one strand of DNA; after replication, a chromosome is made up of two identical chromatids
- **Daughter cells** - new cells produced by cell division
- **Cytokinesis** – a division of the cytoplasm of one parent cell into 2 daughter cells
- **Karyotype:**
 - Diagram of arrangement of chromosomes
 - Chromosomes are paired according to size
 - Arrangement is called karyogram
 - Set of chromosomes is called a karyotype
 - Human karyogram shows the 23 pairs of chromosomes

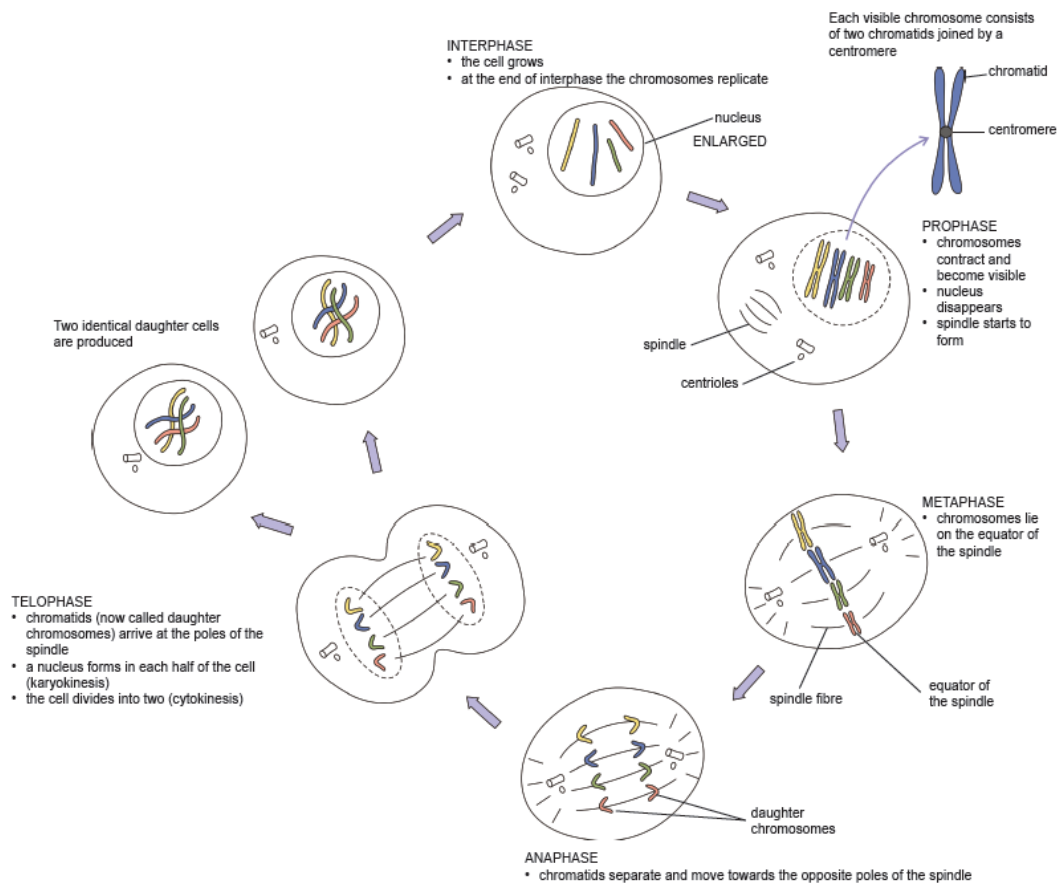




(Figures adapted from Life Sciences for All, Grade 12, Figure 5.5 and Figure 5.6, Page 228)

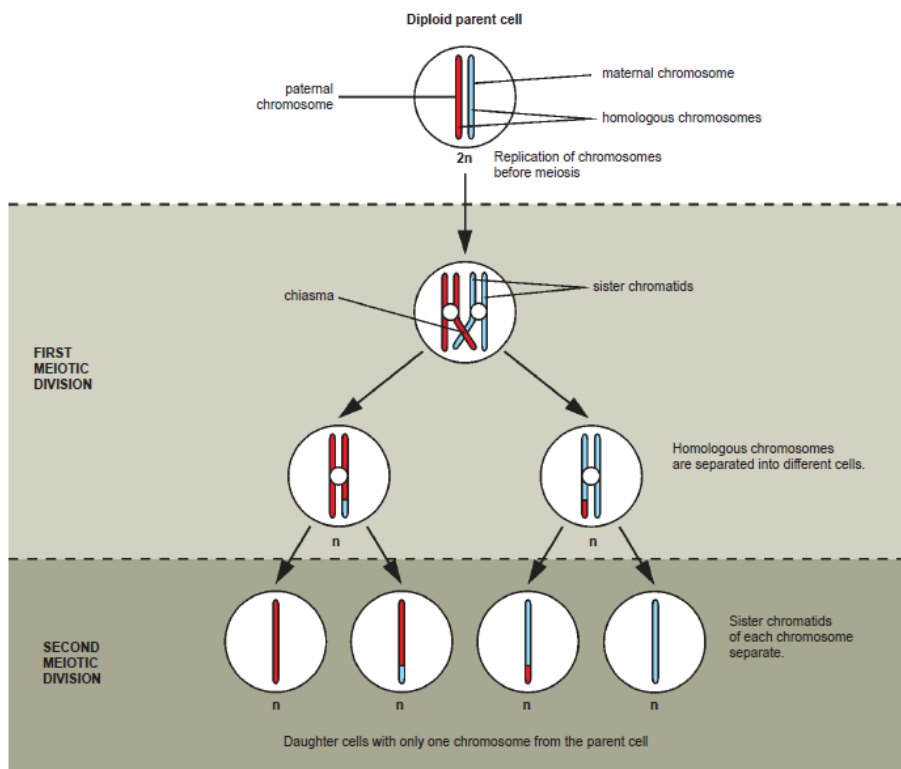
Cell Division:

- The Different Stages of Mitosis:



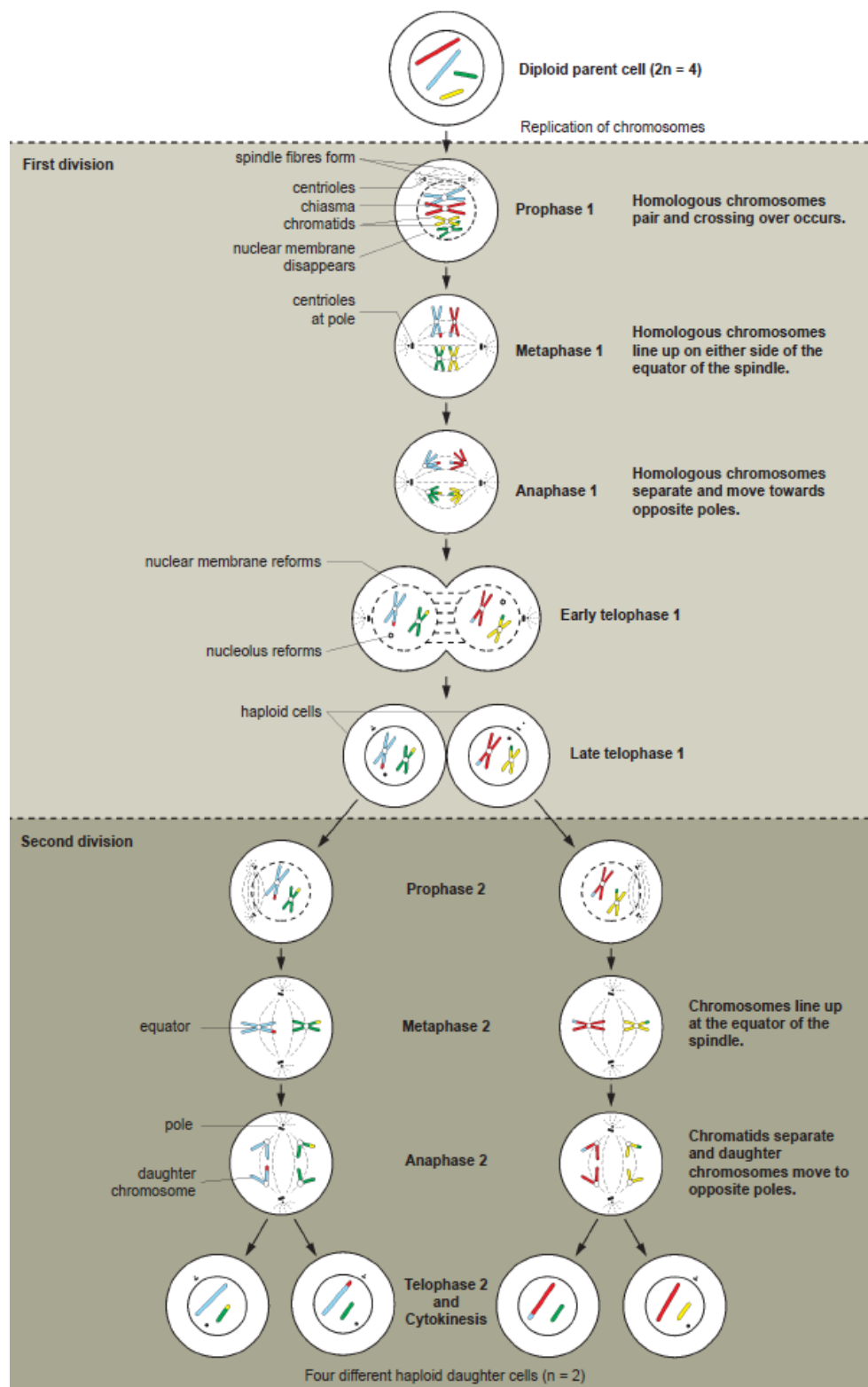
(Figures adapted from Life Sciences for All, Grade 12, Figure 5.8, Page 233)

- The Formation of haploid cells by meiosis:



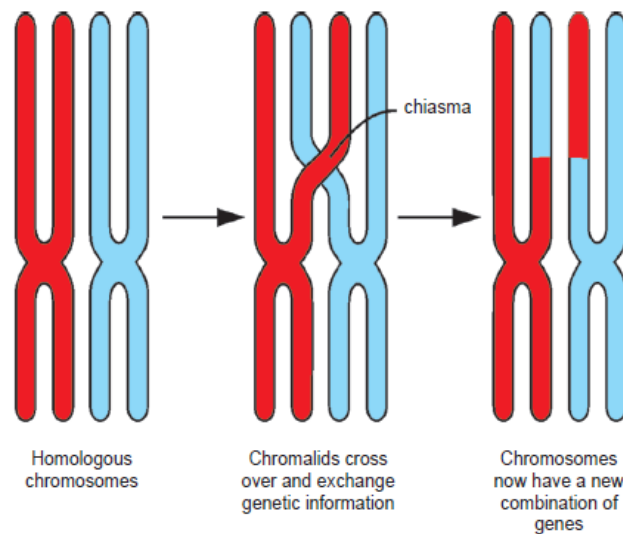
(Figures adapted from *Life Sciences for All, Grade 12, Figure 5.9, Page 234*)

- The behaviour of chromosomes during meiosis:



(Figures adapted from Life Sciences for All, Grade 12, Figure 5.10, Page 236)

- Crossing over during meiosis:



(Figures adapted from *Life Sciences for All, Grade 12, Figure 5.9, Page 235*)

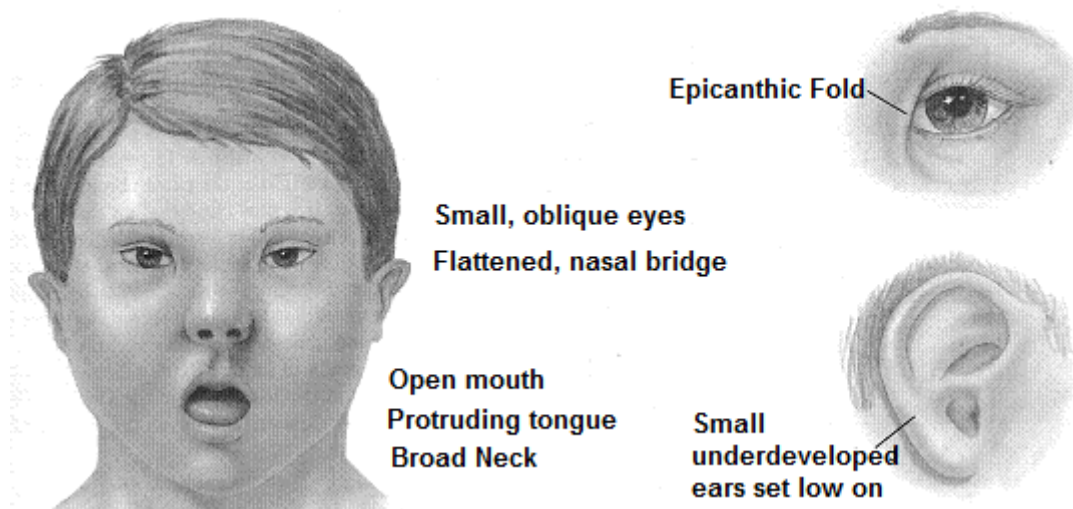
Importance of Meiosis:

- Reduces the number of chromosomes by half
- Formation of gametes - for fertilisation.
- Ensures that the number of chromosomes in the species stays the same over generations
- Meiosis is important to introduce genetic variation.

What happens when meiosis goes wrong?

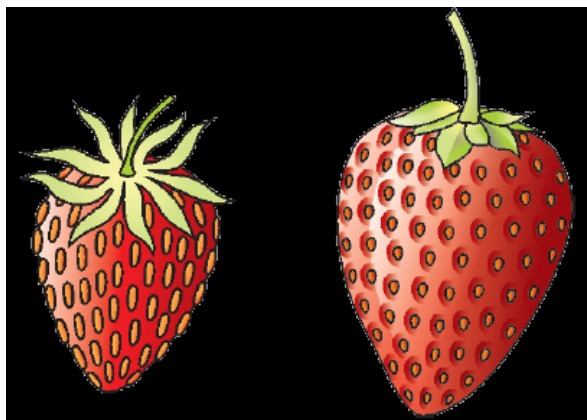
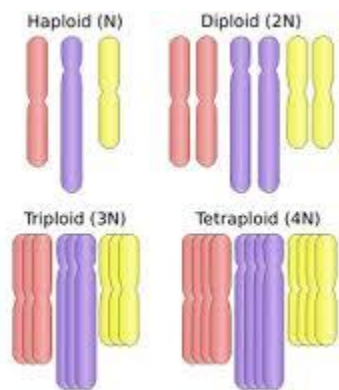
Sometimes meiosis – faulty - one of the pairs of chromosomes does not separate when they move to the poles in the first meiotic division. One of the gametes, usually the ovum, then ends up with an extra chromosome.

In humans, there would be 24 rather than 23 chromosomes in the ovum.



Polyploidy and Agriculture

Not all organisms are haploid or diploid. Some have extra sets of chromosomes in their cells. Organisms with three or more sets of chromosomes are called **polyploids**.



(Figures adapted from *Life Sciences for All, Grade 12, Figure 5.13, Page 240*)

Comparison of Mitosis and Meiosis

Meiosis	Mitosis
Occurs in reproductive organs – testes, ovaries, anthers, sporangia of mosses and ferns	
Occurs in diploid and polyploid cells, not in haploid cells	
Produces gametes in animals, and spores in mosses and ferns	
Two nuclear divisions	
In meiosis 1, homologous chromosomes pair and crossing over occurs	
In meiosis 1, chromosomes line up in their homologous pairs at the equator of the spindle	
In meiosis 1, centromeres do not divide and chromosomes, consisting of two chromatids, move to opposite poles	
Daughter cells that form have half the number of chromosomes as the parent cell	
Four daughter cells produced are genetically different from each other and from the parent cell	

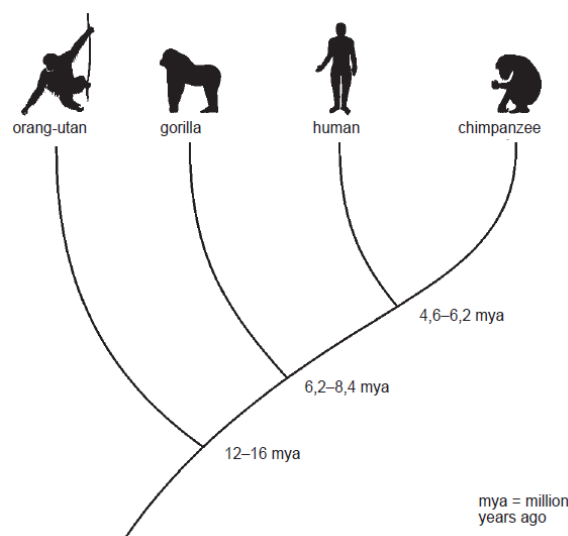


- All organisms have the same method of passing on **hereditary information** from one generation to the next. They all use DNA.
- The greater the similarity between the sequences of bases in the DNA from two different people, the closer their biological relationship is.
- We can also compare the sequence of bases in the DNA of two different species to find out how closely they are related. (this is from last week - if we have time I will do)

Table showing the percentage difference in the DNA between different species and humans and the times that the different species and humans separated from a common line of descent

Primate species	Difference in the DNA between this species and humans (%)	Separation of this species and the humans line (million years ago)
Gorilla	1,62	6,2 to 8,4
Chimpanzee	1,24	4,6 to 6,2
Orang-utan	1,63	12 to 16

(The data in the table is based on research carried out by Feng-Chi Chen of the National Tsing Hua University in Taiwan and Professor Wen-Hsiung Li of the University of Chicago in the USA.)



(Figures adapted from Life Sciences for All, Grade 12, Figure 4.32, Page 207)

Questions

Question 1

(Life Sciences for all, Grade 12, Question 1, Page 242)

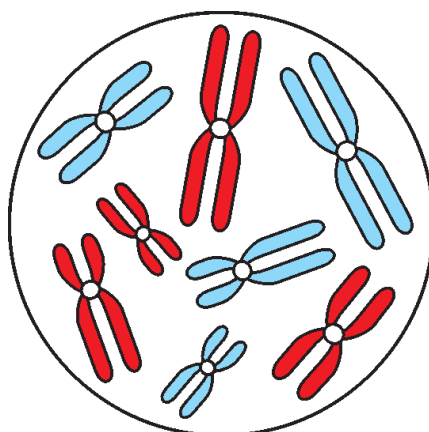
Give the correct word or term for the following:

- a.) an organism with more than two complete sets of chromosomes
- b.) the point at which chromatids exchange genetic material during meiosis
- c.) the type of cell division that forms gametes in diploid organisms
- d.) the type of cell division that occurs in somatic cells
- e.) division of the cytoplasm that takes place during division of a cell
- f.) the reproductive organ in human females in which meiosis occurs.

Question 2

(Life Sciences for all, Grade 12, Question 2, Page 241)

Refer to the diagram below:



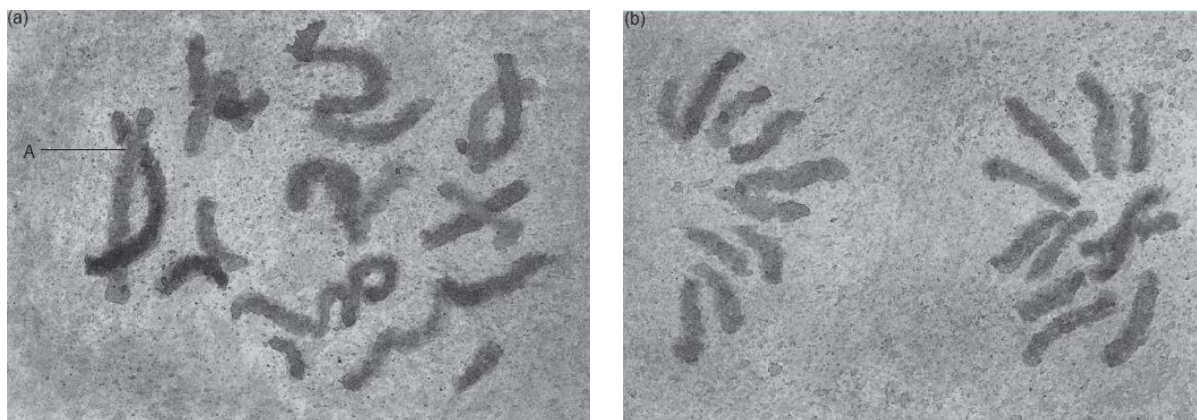
(Figures adapted from Life Sciences for All, Grade 12, Figure 5.14, Page 241)

- a.) Give the number for each of the following in this diploid nucleus at the start of meiosis:
 - i. chromatids
 - ii. chromosomes
 - iii. pairs of homologous chromosomes
 - iv. molecules of DNA
 - v. centromeres.
- b.) Give the number for each of the following in a gamete formed from this cell by meiosis:
 - i. chromatids
 - ii. chromosomes
 - iii. pairs of homologous chromosomes.

Question 3

(Life Sciences for all, Grade 12, Question 3, Page 242)

Look at the drawings below:



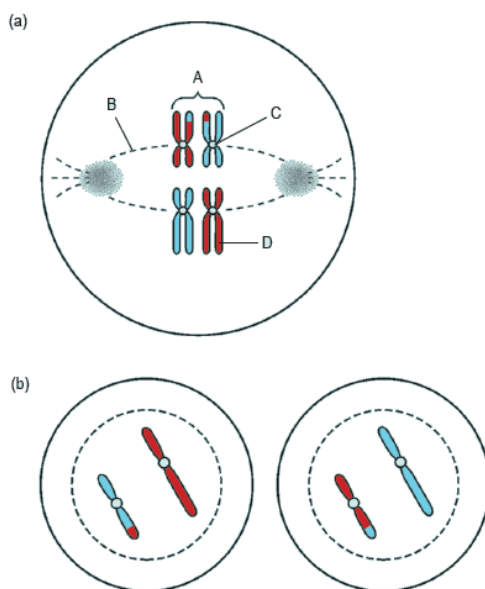
(Figures adapted from Life Sciences for All, Grade 12, Figure 5.15, Page 242)

- Describe what is occurring at A. Explain the biological importance of this event.
- Describe what is happening to the chromosomes in the figure above (b).
- What is the diploid number of the animal from which these cells have been taken?
- In which organ/s of the animal would cells like this be found?

Question 4

(Life Sciences for all, Grade 12, Question 4, Page 242)

Study the diagram and answer the questions that follow.



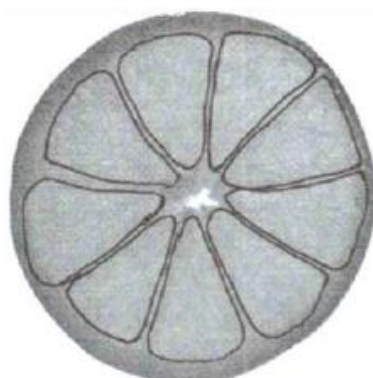
- Write down the term that best describes the paired chromosomes labelled A.
- Would you see structures labelled A with the naked eye or with a microscope?
- Give one way in which the chromosomes labelled A are (i) similar and (ii) different.

- d.) Provide labels for parts B, C and D.
- e.) How many chromosomes are shown in the diagram in Figure (a)?
- f.) How many chromosomes are there in each cell at the end of meiosis?
- g.) The figure above shows two of the cells that could form from the animal cell at the end of meiosis. Draw the remaining cells in a similar fashion. Do not include labels

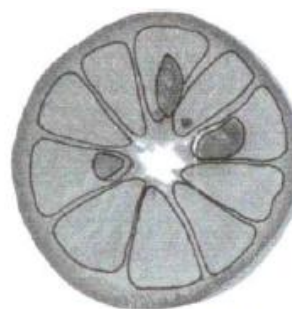
Question 5

(Adapted from IEB 2011, Question 5.2.2)

The diagrams below are cross sections of two different oranges. These are drawn to the same scale.



Triploid Orange



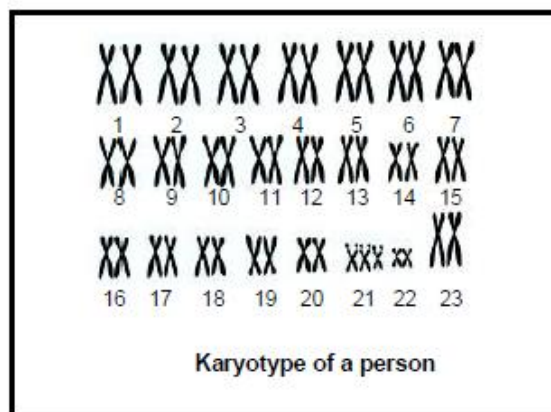
Diploid Orange With Seeds

- a.) Which of these oranges is an example of polyploidy? Give a visible reason for your answer. (2)
- b.) What is the advantage of polyploidy in this plant? (1)

Question 6

(Adapted from DBE November 2008)

Study the diagram below and answer the questions that follow:



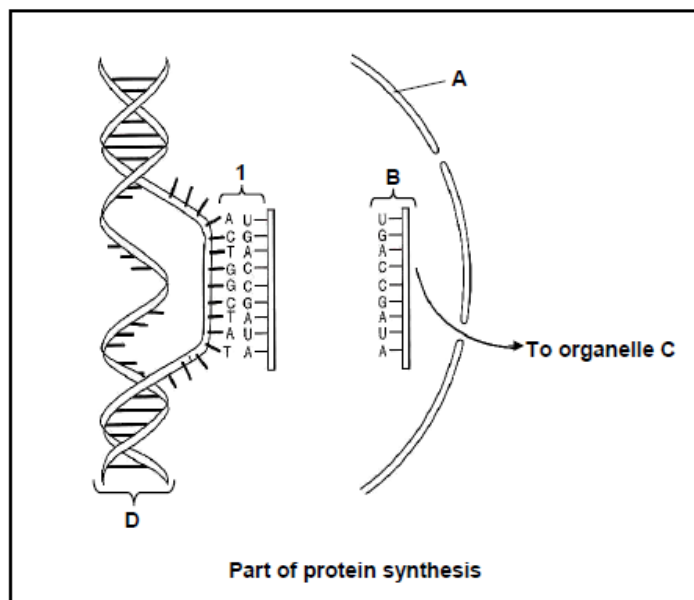
- a.) Is this the karyotype of a male or a female? (1)
- b.) Give a reason for your answer to QUESTION (a.). (2)

- c.) How many chromosomes does this person have? (1)
- d.) Name the genetic disorder that this person has. (1)

Question 7

(Adapted from March 2010, DOE, P1, Question 2.2)

Study the diagram below which shows part of the process of protein synthesis.



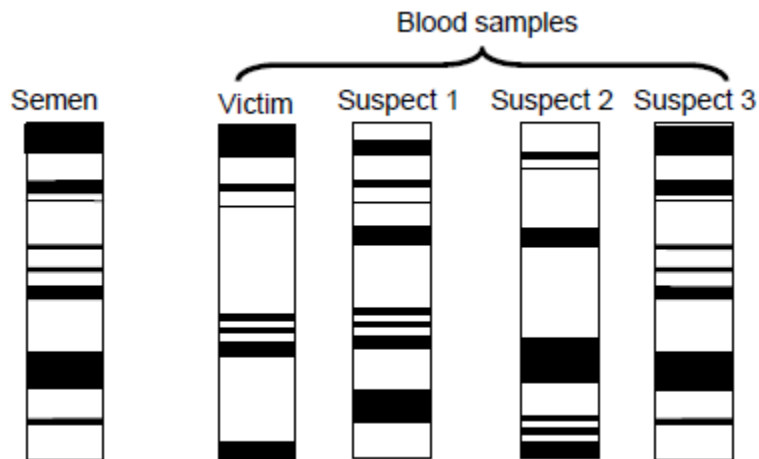
- a.) Provide labels for structures A, B and D respectively. (3)
- b.) State ONE function of molecule D. Which part of protein synthesis takes place at 1? (1)
- c.) Which part of protein synthesis takes place at 1? (1)
- d.) Name the type of proteins that control the process named in QUESTION (c). (1)
- e.) Identify organelle C. (1)
- f.) Name and describe the part of protein synthesis that takes place at organelle C. (6)

Question 8

(Adapted from March 2010, DOE, P1, Question 2.3)

Study the diagram below which shows the following DNA profiles/genetic fingerprints:

- Blood of a raped female victim
- Blood of three suspects
- Semen found on the female victim



DNA profiles compiled by forensic scientists

- a.) Which suspect was most likely the rapist? (1)
- b.) Explain your answer to QUESTION (a). (2)
- c.) Give ONE reason why this evidence may be considered reliable. (1)
- d.) Give TWO reasons why this evidence may not be considered reliable. (2)
- e.) Name TWO benefits of DNA profiling other than for solving crimes. (2)

Question 9

(Adapted from Exemplar 2011)

Describe how proteins are formed in a cell and explain the impact of the two types of gene mutations on the formation of proteins. (20)