3. Genetics – 3.3 Meiosis

Name:

Understandings, Applications and Skills (This is what you maybe assessed on)

	Statement	Guidance
3.3.U1	One diploid nucleus divides by meiosis to produce four haploid nuclei.	
3.3.U2	The halving of the chromosome number allows a sexual life cycle with fusion of gametes.	
3.3.U3	DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids.	
3.3.U4	The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation.	The process of chiasmata formation need not be explained.
3.3.U5	Orientation of pairs of homologous chromosomes prior to separation is random.	
3.3.U6	Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number.	
3.3.U7	Crossing over and random orientation promotes genetic variation.	
3.3.U8	Fusion of gametes from different parents promotes genetic variation.	
3.3.A1	Non-disjunction can cause Down syndrome and other chromosome abnormalities.	
3.3.A2	Studies showing age of parents influences chances of non-disjunction.	
3.3.A3	Description of methods used to obtain cells for karyotype analysis e.g. chorionic villus sampling and amniocentesis and the associated risks.	
3.3.S1	Drawing diagrams to show the stages of meiosis resulting in the formation of four haploid cells.	Drawings of the stages of meiosis do not need to include chiasmata. Preparation of microscope slides showing meiosis is challenging and permanent slides should be available in case no cells in meiosis are visible in temporary mounts.

Recommended resources:

http://bioknowledgy.weebly.com/33-meiosis.html

Allott, Andrew. *Biology: Course Companion.* S.l.: Oxford UP, 2014. Print.

Nature of Science: Making careful observations - meiosis was discovered by microscope examination of dividing germ-line cells. (1.8)

In the 19th century was very difficult to observe the behaviour of chromosomes in cell: the choice of organism and tissue, slide preparation and interpreting microscope images are all difficult to do successfully. It therefore it took years of careful examination by Scientists to discover and fully understand meiosis.

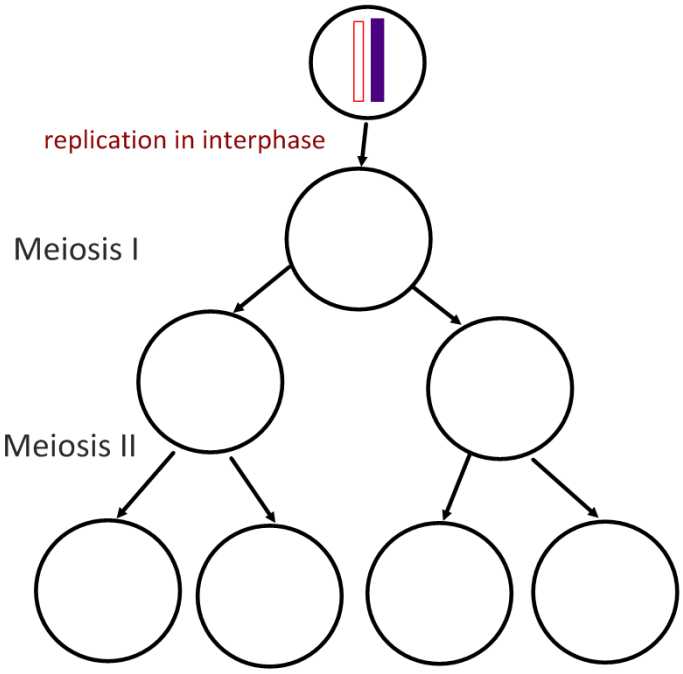
3.3.U1 One diploid nucleus divides by meiosis to produce four haploid nuclei.

1. State the function of meiosis.

2. State the definition of the term homologous chromosome.

3. Explain why meiosis is described as a reduction division.

4. Add chromosomes and annotate the diagram below summarising the key steps in meiosis. Identify where crossing over occurs and state its effect.



3.3.S1 Drawing diagrams to show the stages of meiosis resulting in the formation of four haploid cells. AND 3.3.U3 DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids. AND 3.3.U4 The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation. AND 3.3.U5 Orientation of pairs of homologous chromosomes prior to separation is random. AND 3.3.U6 Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number.

5. Outline the events and movements of chromosomes occurring during the different stages of meiosis:

Meiosis I		
Phase	**Events**	**Labelled Diagram**
Interphase (s-phase)		
Prophase I		
Metaphase I		
Anaphase I		
Telophase I		

Meiosis II		
Phase	**Events**	**Labelled Diagram**
Prophase II		
Metaphase II		
Anaphase II		
Telophase II		
Cytokinesis		

3.3.U7 Crossing over and random orientation promotes genetic variation.

6. Crossing over occurs in prophase I. State the result of the process and explain how this increases the genetic variation found in gametes.

7. Outline how random orientation in metaphase I leads to further genetic variation and state the number of possible orientations in human cells.

8. Explain why random orientation in metaphase II is less important to genetic variation than random orientation in metaphase I.

3.3.U8 Fusion of gametes from different parents promotes genetic variation.

9. Outline how sexual reproduction leads to even further genetic variation within a species.

Knowledge review questions

10. Complete the table to compare and contrast mitosis and meiosis:

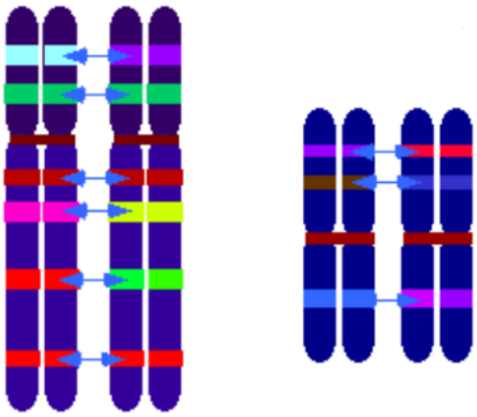
	Mitosis	Meiosis
Number of divisions		
Number of daughter cells		
Chromosome number in daughter cells		
Behaviour of chromosomes:		
Functions/Uses:		

11. Deduce the answers to these questions.
    a. A cell with a diploid number of 12 chromosomes undergoes meiosis. How many daughter cells will be produced and with how many chromosomes in each?

    b. A gamete contains 18 chromosomes. How many chromosomes in the somatic cell?

    c. A diploid cell with 16 chromosomes undergoes meiosis. How many chromatids are present in metaphase I?

12. Describe what you can see in the image to the right.



13. State during which stage of meiosis is the image most likely to be seen.

14. Distinguish between chromosomes, sister chromatids and bivalents.

3.3.U2 The halving of the chromosome number allows a sexual life cycle with fusion of gametes.

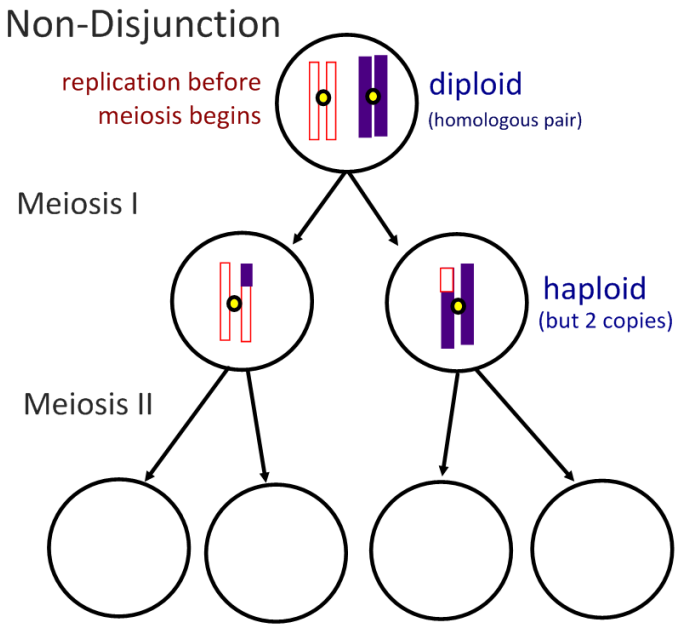
15. Complete the table to show how the chromosome number changes during a sexual life cycle.

Stage of the sexual life cycle	Chromosome number (N/2N)	Haploid or Diploid
Adults		
Gametes (egg and sperm cells)		
Zygote		
Juvenile		

16. Explain what would be the consequence to the sexual life cycle if meiosis failed to reduce the chromosome number.

3.3.A1 Non-disjunction can cause Down syndrome and other chromosome abnormalities.

17. Annotate the diagram below to show what happens in non-disjunction in meiosis II.



18. Describe how non-disjunction and fertilisation lead to trisomy.

19. Distinguish between non-disjunction and trisomy.

20. Compare and constrast between the outcomes of non-disjunction in anaphase I with anaphase II:

Non-disjunction in…	**Anaphase I**	**Anaphase II**
Number of normal cells		
Cells with extra chromosome (n+1)		
Cells with chromosome missing (n-1)		

21. *Down syndrome* is caused by a trisomy of chromosome number 21. Describe how *Down syndrome* effects an individual.

<u>3.3.A3 Description of methods used to obtain cells for karyotype analysis e.g. chorionic villus sampling and amniocentesis and the associated risks.</u>

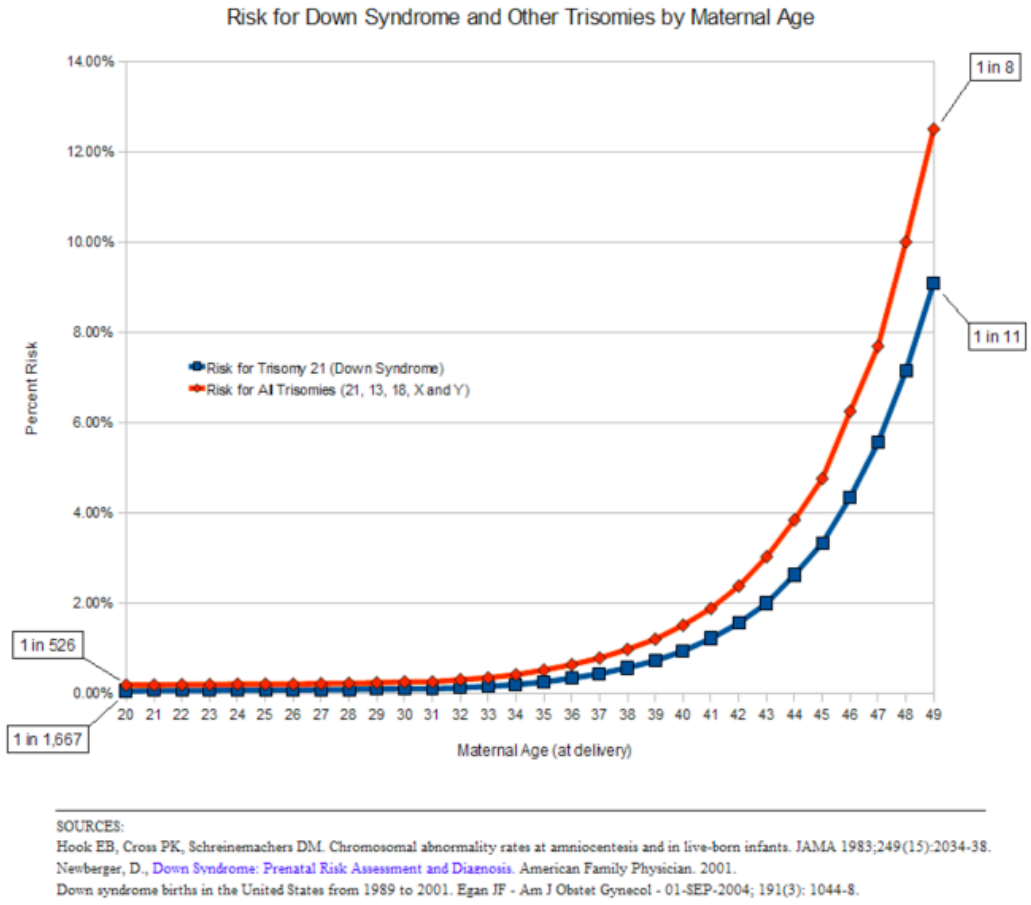
22. A karyotype can be used to test for non-disjunction disorders. Fetal cells are taken and the number of chromosomes counted. Outline how these cells are retrieved and the risks involved:

    Chorionic Villus Sampling (CVS):

    Amniocentesis:

3.3.A2 Studies showing age of parents influences chances of non-disjunction.

23. The graph show the effect of maternal age on the % risk of a pregnancy resulting in Down Syndrome and other trisomies.



source: https://commons.wikimedia.org/wiki/File:Down_Syndrome_Risk_By_Age.png

24. Outline the effect of maternal age on likelihood of Down Syndrome.

25. Evaluate the risk of a *Down Syndrome* to a 46 year old pregnant woman with the risk of a miscarriage caused by amniocentesis (1%) and chorionic villus sampling (2%).

Citations:

Allott, Andrew. *Biology: Course Companion.* S.l.: Oxford UP, 2014. Print.

Taylor, Stephen. " Essential Biology 4.2 Meiosis core.docx." Web. 16 Jul. 2015. <http://www.slideshare.net/gurustip/essential-biology-42-meiosis-core>.