3.2 Meiosis

Mark Schemes

Course	DP IB Biology
Section	3. Genetics
Topic	3.2 Meiosis
Difficulty	Medium

To be used by all students preparing for DP IB Biology SL
Students of other boards may also find this useful

1

The correct answer is **B**; the first nuclear division, or meiosis I, separates the homologous pairs, and so generates haploid cells. Be careful not to confuse this with the separation of the sister chromatids which occurs during meiosis II.

A is incorrect; meiosis is a mechanism of nuclear division that occurs in **eukaryotic** cells, and specifically the cells of the **reproductive organs**. Prokaryotic cells do not have a nucleus and so divide by binary fission, while normal body cells divide by mitosis.

C is incorrect; while interphase is part of the cell cycle, it is separate from meiosis, which consists of prophase, metaphase, anaphase, and telophase (all occur twice during meiosis).

D is incorrect; meiosis is very important for the generation of genetic variation in sexual reproduction, but the process of mutation, which generates new alleles, can also take place in cells that divide by mitosis.

2

The correct answer is **D**; the development of sufficiently powerful light microscopes and stains that could dye the contents of nucleus enabled scientists to view the events and results of meiosis.

The hypothesis given in option **A** came **after** the early observations of meiosis.

Option **B** is incorrect because electron microscopes were developed in the early 20th century, while the discovery of meiosis occurred in the late 19th century.

Option **C** is incorrect; a key research organism in the discovery of meiosis was the rabbit, in which meiosis takes place very **slowly** in young females; this would have increased the likelihood of catching cells in the process of meiosis.

3

The correct answer is **C** because **Y** is the stage at which the *2n* (diploid) sorus gives rise to *n* (haploid) spores.

Option A is incorrect because **W** is fertilisation, during which the n gametes fuse to form the *2n* zygote.

Option B and **D** are incorrect as **X** and **Z** are both mitosis. We can see this because growth takes place and the chromosome number does not change. Don't be misled by the production of gametes in stage **Z**; this is an unusual life cycle in comparison to what you may have come across before.

Note that you are not expected to know anything about the life cycle of ferns, but you should be able to use information about haploid and diploid life cycle stages to determine when meiosis occurs.

4

The correct answer is **D**.

- DNA replication occurs before nuclear division (stage 1), and the chromosomes change from single strands to sister chromatids joined at the centromere.
- Crossing over takes place during meiosis I (stage 2) while the homologous pairs line up.
- Sister chromatids are separated during meiosis II (stage 3).

While random orientation and separation of homologous pairs are both processes that occur during stage 2, both **B** and **C** have other incorrect statements.

- Option **B** incorrectly identifies stage 1 as mitosis.
- Option **C** incorrectly describes stage 3 as separation of homologous pairs.

While stages 1 and 3 are correctly described in **A**, random fertilisation occurs after meiosis and so is incorrect.

5

The correct answer is **B**. You should begin by identifying whether the cells are in meiosis I or II; here there are already 2 cells in most images, and one image shows 4 cells forming, so they must be in meiosis II. The detailed stages can be identified by looking at the positions of the chromosomes.

If the cells were in meiosis I there would be only 1 cell in most images, and then 2 cells forming in an image showing telophase I.

6

The correct answer is **B**.

Statement II is incorrect; *n* represents the number of **pairs** of chromosomes in a diploid cell, or the **haploid** chromosome number, **not** the number of chromosomes in a diploid cell. E.g. in humans there are 23 homologous pairs of chromosomes, and therefore 2^{23} possible combinations as a result of random orientation.

7

The correct answer is **C**. The graph shows that as the distance from the centromere increases, so does the number of crossing over events. As this set of results was gained from male trout, the conclusion can only be applied to male trout.

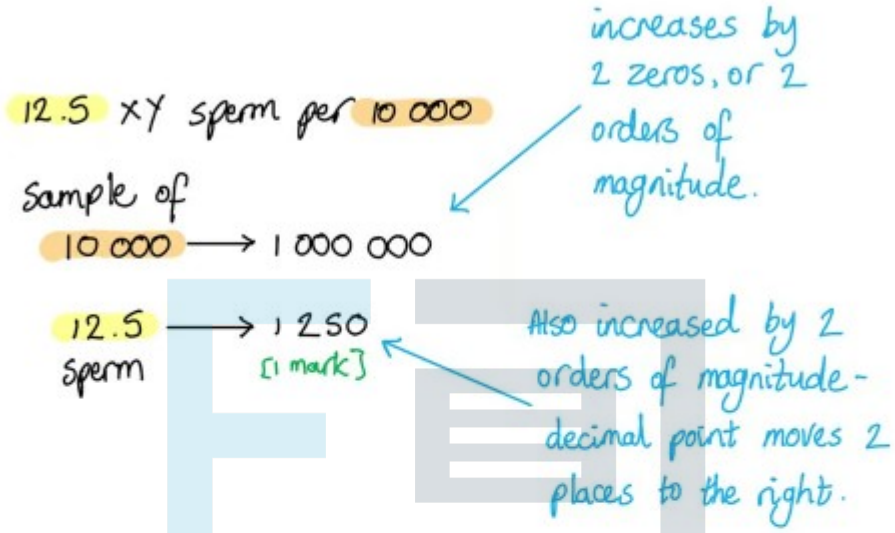
A is incorrect because we have no statistical analysis to tell us whether the difference in crossing over events at different distances from the centromere is significant.

B is an incorrect reading from the graph; 30 % of crossing over events occurs at a relative distance of 0.8.

D is incorrect because it attempts to apply these results to all fish species; more research would be needed before this conclusion could be reached.

8

The correct answer is **A**. The graph shows that in the age range of 40–49, there would be 12.5 XY sperm per 10 000 sperm. This then needs to be scaled up to find out the number of XY sperm per 1 000 000.



9

The correct answer is **D**.

- Amniotic fluid is collected via a needle through the abdomen wall.
- Homologous pairs are arranged by size **digitally**.
- Karyo**grams** are images that can be analysed to search for chromosome abnormalities.

A tube via the vagina collects cells from the chorion, not the amniotic fluid.

Chromosome images used to be rearranged manually using negatives and scissors, but the rearranging of chromosomes is now all done digitally.

Be careful not to mix up a karyogram, which is an image of the chromosomes arranged by size, and a karyotype, which is the chromosomes that an organism has. While a karyotype can be analysed, it cannot be described as an image.

10

The correct answer is **B**. Individual chromosomes are distinguishable due to their being condensed, and they are randomly arranged; not yet lined up as they would be had the cell progressed on to metaphase. Only one parent cell is visible, so we know that this is prophase I and not prophase II.

A incorrectly identifies prophase II.

C states incorrectly that the cell is haploid; this would not be the case until prophase II.

D correctly describes metaphase, but this does not match with what can be seen in the cell.