3.1 Genes & Chromosomes

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Course	DP IB Biology
Section	3. Genetics
Topic	3.1 Genes & Chromosomes
Difficulty	Medium

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

1

The correct answer is **A**; a particular gene occupies a specific position, or locus, on a chromosome, and this position will be the same across all individuals in a species.

2

The correct answer is **C**.

- Mutations in an existing allele can give rise to a new allele.
- Eukaryotic chromosomes exist in **homologous pairs**, with each member of the pair carrying one allele of a gene; this means that every eukaryotic cell has two alleles of every gene.

Some genes may have two different versions, or alleles, but it is also possible to have more than two, or **multiple alleles** of a gene. A single eukaryotic cell, however, will only have a maximum of two alleles for any one gene.

3

The correct answer is **C**; this is a substitution mutation in which thymine (T) is replaced by adenine (A). The resulting mRNA codon GUG codes for valine instead of glutamic acid, altering the folding of the protein and leading to a faulty version of haemoglobin.

In **A**, glutamic acid and valine are the wrong way around.

B describes the healthy haemoglobin allele, which is known as Hb^A; the sickle cell allele is known as Hb^S.

D gives the incorrect amino acid position; the substitution mutation in sickle cell anaemia takes place at the 6th position.

4

The correct answer is **C**.

The sequencing of the human genome does not mean that scientists now know everything about human genes, but it provides a huge amount of data that enables scientists to learn more about the structure of genes and predict their function from e.g. looking at correlation data.

Genome technology today is dependent on the power of computers and databases, and as these grow more powerful we can expect the rate at which a genome can be sequenced and analysed to increase even further.

5

The correct answer is **B**; Cairns was able to see this by viewing his results under an electron microscope.

We now know **A** to be true, but this particular study only involved *E. coli*, so this conclusion cannot be drawn from its results.

Autoradiography is the name of the technique that Cairns used in this study, and it revealed a **single**, circular chromosome; **C** is therefore incorrect.

Cairns did later go on to discover **D**, but did not see it in this particular study.

6

The correct answer is **A**.

DNA wraps around histone proteins to form **chromatin**. Chromatids are the two strands of DNA (known as sister chromatids) that make up the chromosome after DNA replication has occurred and before cell division. Note that because chromatids form the chromosome, they too are made of chromatin.

7

The correct answer is **D**; a diploid (2n) cell in the zygote gives rise to more diploid (2n) cells in the embryo. The type of cell division that gives rise to identical cells in this way is mitosis.

Fertilisation would cause the chromosome number to double, and can be seen in the life cycle at the point at which the haploid egg and sperm cells (n) fuse to form the diploid zygote (2n). Note that the term 'fusion' given in option **C** is really just a description of the process of fertilisation given in **A**, rather than being a biological process in itself.

In meiosis we should see diploid (2n) cells becoming haploid (n); this occurs at the point at which the sporophyte (2n) becomes spores (n).

Note that it doesn't matter if you have never heard of a sporophyte or a gametophyte; as long as you understand the cellular processes of cell division and fertilisation, you know enough to answer this question.

8

The correct answer is **C**. Female gametes all contain X chromosomes, whereas male gametes contain half X and half Y chromosomes. It is therefore the male gamete that determines the sex of the offspring and not the female.

Both sperm cells and egg cells contain sex chromosomes, meaning that **A** and **D** are incorrect statements.

Fathers have both an X and a Y chromosome, so can pass on either to their offspring.

9

The correct answer is **B**. The individual has an X and a Y chromosome, so they are male, and they have 3 chromosomes instead of 2 in pair 22.

The individual does not have Down syndrome, as this would involve 3 chromosomes in pair 21 (Down syndrome is sometimes known as trisomy 21).

10

The correct answer is **D**. There are online gene databases that are freely available for anyone to access e.g., GenBank, OMIM and GOLD.