

This paper covers the **full Higher Separate** specification. Higher Tier questions are marked ★. Separate-only questions are marked ◆.

## DNA and Chromosomes (4.6.2)

*Specification reference: 4.6.2*

**Q1. Describe the structure of a DNA molecule.**

[3 marks]

---

---

---

---

---

**Q2. Explain the relationship between DNA, genes and chromosomes.**

[3 marks]

---

---

---

---

---

### ★ HIGHER TIER

**Q3. ★ Describe the process of protein synthesis, naming the molecules and locations involved.**

[4 marks]

---

---

---

---

---

---

---

---

---

---

## Meiosis and Reproduction (4.6.1)

*Specification reference: 4.6.1*

**Q4. Explain why meiosis produces cells that are genetically different from each other.**

[3 marks]

---

---

---

---

---

**Q5. Compare sexual and asexual reproduction in terms of the number of parents, genetic variation and type of cell division.**

[3 marks]

---

---

---

---

---

---

---

---

### **Genetic Inheritance and Punnett Squares (4.6.3)**

*Specification reference: 4.6.3*

**Q6. Define the following terms: (a) dominant allele, (b) recessive allele, (c) genotype, (d) phenotype.**

[4 marks]

---

---

---

---

---

---

---

---

**Q7. Brown eye colour (B) is dominant over blue (b). Two parents both have genotype Bb. Use a Punnett square to calculate the probability their child has blue eyes.**

[3 marks]

---

---

---

---

---

---

---

---

**Q8. Polydactyly is caused by a dominant allele (D). Cystic fibrosis is caused by a recessive allele (f). Explain why someone with one copy of the polydactyly allele (Dd) will have extra digits, but a cystic fibrosis carrier (Ff) will appear unaffected.**

[3 marks]

---

---

---

---

---

---

---

---

#### **★ HIGHER TIER**

**Q9. ★ Explain what is meant by co-dominance. Give ONE example.**

[2 marks]

---

---

---

---

---

---

---

---

## Natural Selection and Evolution (4.6.5)

Specification reference: 4.6.5

**Q10. Describe how natural selection can lead to changes in a species over many generations. Use all of the following terms: variation, competition, survival, inheritance.**

[5 marks]

---

---

---

---

---

---

---

---

---

---

**Q11. State THREE pieces of evidence that support the theory of evolution.**

[3 marks]

---

---

---

---

---

---

★ HIGHER TIER

**Q12. ★ Explain how speciation can occur when a population of organisms becomes geographically isolated.**

[4 marks]

---

---

---

---

---

---

---

---

★ HIGHER TIER

**Q13. ★ Describe the process of genetic engineering. Name the enzymes used at each stage.**

[4 marks]

---

---

---

---

---

---

---

---

---

**Total: 44 marks**

## DNA and Chromosomes (4.6.2)

### Q1 (3 marks)

*Describe the structure of a DNA molecule.*

- Double helix — two strands twisted together [1]
- Made of nucleotides, each containing a sugar, phosphate and one of four bases (A, T, C, G) [1]
- Complementary base pairing: A-T and C-G hold the two strands together [1]

### Q2 (3 marks)

*Explain the relationship between DNA, genes and chromosomes.*

- DNA is a long molecule carrying genetic information [1]
- A gene is a section of DNA that codes for a specific protein/characteristic [1]
- Chromosomes are long strands of DNA coiled up and carrying many genes — humans have 46 in 23 pairs [1]

### Q3 (4 marks) [★ HT]

*★ Describe the process of protein synthesis, naming the molecules and locations ...*

- Transcription in nucleus: template strand of DNA copied into mRNA using complementary base pairing (U replaces T in mRNA) [1]
- mRNA leaves nucleus through nuclear pores [1]
- Translation at ribosome: ribosome reads mRNA codons (triplets of 3 bases) [1]
- tRNA molecules bring specific amino acids; peptide bonds form between amino acids → polypeptide chain (protein) [1]

## Meiosis and Reproduction (4.6.1)

### Q4 (3 marks)

*Explain why meiosis produces cells that are genetically different from each other...*

- During meiosis, homologous chromosomes pair up and sections of DNA are exchanged (crossing over) — creating new allele combinations [1]
- Chromosomes then separate randomly (independent assortment) — each gamete receives a random mix of maternal and paternal chromosomes [1]
- Fertilisation combines two gametes — the combination of alleles in offspring is unique [1]

### Q5 (3 marks)

*Compare sexual and asexual reproduction in terms of the number of parents, genet...*

- Asexual: one parent; sexual: two parents [1]
- Asexual: offspring are genetically identical (clones); sexual: offspring are genetically different [1]
- Asexual: uses mitosis; sexual: uses meiosis (to produce gametes) [1]

## Genetic Inheritance and Punnett Squares (4.6.3)

### Q6 (4 marks)

*Define the following terms: (a) dominant allele, (b) recessive allele, (c) genot...*

- (a) An allele that is expressed when only one copy is present — masks recessive [1]
- (b) An allele that is only expressed when two copies are present [1]
- (c) The alleles an individual carries (e.g. Bb) [1]
- (d) The observable characteristic produced by the genotype (e.g. brown eyes) [1]

### Q7 (3 marks)

*Brown eye colour (B) is dominant over blue (b). Two parents both have genotype B...*

- Correct Punnett square: BB, Bb, Bb, bb [1]
- 1 in 4 / 25% probability of blue eyes (bb genotype) [1]
- Phenotype ratio: 3 brown : 1 blue [1]

**Q8 (3 marks)**

*Polydactyly is caused by a dominant allele (D). Cystic fibrosis is caused by a r...*

- Polydactyly allele is dominant — expressed whenever present, even with only one copy [1]
- Cystic fibrosis allele is recessive — only expressed when two copies present (ff) [1]
- Carrier (Ff) has one dominant normal allele that masks the recessive cystic fibrosis allele [1]

**Q9 (2 marks) [★ HT]**

*★ Explain what is meant by co-dominance. Give ONE example.*

- Co-dominance: both alleles are expressed equally in the phenotype of a heterozygote — neither dominates [1]
- Example: ABO blood group — I<sup>A</sup> and I<sup>B</sup> are co-dominant; I<sup>A</sup> I<sup>B</sup> genotype gives type AB blood [1] — accept: sickle cell trait

---

**Natural Selection and Evolution (4.6.5)****Q10 (5 marks)**

*Describe how natural selection can lead to changes in a species over many genera...*

- Variation exists within a population due to mutations and sexual reproduction [1]
- Individuals compete for limited resources (food, water, mates, space) [1]
- Individuals with advantageous characteristics are more likely to survive and reproduce [1]
- Survivors pass on the alleles for their advantageous characteristics to offspring (inheritance) [1]
- Over many generations, the frequency of advantageous alleles increases — the population changes [1]

**Q11 (3 marks)**

*State THREE pieces of evidence that support the theory of evolution.*

- Fossil record — shows gradual changes in species over millions of years [1]
- DNA evidence — closely related species share more similar DNA sequences [1]
- Observable examples of natural selection today (e.g. antibiotic resistance in bacteria) [1] — accept: comparative anatomy

**Q12 (4 marks) [★ HT]**

*★ Explain how speciation can occur when a population of organisms becomes geogra...*

- A barrier (mountain range, sea, river) divides the population into two isolated groups [1]
- The two groups experience different environmental conditions → different selection pressures [1]
- Different mutations arise and different alleles are selected for in each group [1]
- Over many generations, the two groups become so genetically different they can no longer interbreed to produce fertile offspring → new species [1]

**Q13 (4 marks) [★ HT]**

*★ Describe the process of genetic engineering. Name the enzymes used at each sta...*

- Desired gene identified and cut out of donor DNA using restriction enzymes [1]
- Plasmid (vector) cut open with the same restriction enzyme → complementary sticky ends [1]
- Gene inserted into plasmid; DNA ligase seals the joins → recombinant DNA [1]
- Recombinant plasmid introduced into host cell (e.g. bacterium); host expresses the gene and produces the desired protein [1]