CHAPTER 17
INHERITANCE

The stuff you need to know in this chapter:

17.1 INHERITANCE

Core

- Define inheritance as the transmission of genetic information from generation to generation

17.2 CHROMOSOMES, GENES AND PROTEINS

Core

- Define chromosome as a thread-like structure of DNA, carrying genetic information in the form of genes
- Define gene as a length of DNA that codes for a protein
- Define allele as a version of a gene
- Describe the inheritance of sex in humans with reference to XX and XY chromosomes

Extended

- Explain that the sequence of bases in a gene is the genetic code for putting together amino acids in the correct order to make a specific protein (knowledge of the details of nucleotide structure is **not** required)
- Explain that DNA controls cell function by controlling the production of proteins (some of which are enzymes), antibodies and receptors for neurotransmitters
- Explain how a protein is made, limited to:
  - the gene coding for the protein remains in the nucleus
  - mRNA molecules carry a copy of the gene to the cytoplasm
  - the mRNA passes through ribosomes
  - the ribosome assembles amino acids into protein molecules
  - the specific order of amino acids is determined by the sequence of bases in the mRNA (knowledge of the details of transcription or translation is **not** required)
- Explain that all body cells in an organism contain the same genes, but many genes in a particular cell are not expressed because the cell only makes the specific proteins it needs
- Define a haploid nucleus as a nucleus containing a single set of unpaired chromosomes, e.g. in gametes
- Define a diploid nucleus as a nucleus containing two sets of chromosomes, e.g. in body cells
- State that in a diploid cell, there is a pair of each type of chromosome and in a human diploid cell there are 23 pairs

17.3 MITOSIS

Core

- Define mitosis as nuclear division giving rise to genetically identical cells (details of stages are **not** required)
- State the role of mitosis in growth, repair of damaged tissues, replacement of cells and asexual reproduction

Extended

- State that the exact duplication of chromosomes occurs before mitosis
- State that during mitosis, the copies of chromosomes separate, maintaining the chromosome number (details of stages of mitosis are **not** required)
- Describe stem cells as unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

17.4 MEIOSIS

Core

- Define meiosis as nuclear division giving rise to cells that are genetically different (details of stages are **not** required)
- State that meiosis is involved in the production of gametes

Extended

- Define meiosis as reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells (details of stages are **not** required)
- Explain how meiosis produces variation by forming new combinations of maternal and paternal chromosomes (specific details are **not** required)

17.5 MONOHYBRID INHERITANCE

Core

- Define genotype as the genetic make-up of an organism in terms of the alleles present
- Define phenotype as the observable features of an organism
- Define homozygous as having two identical alleles of a particular gene
- State that two identical homozygous individuals that breed together will be pure-breeding
- Define heterozygous as having two different alleles of a particular gene
- State that a heterozygous individual will not be pure-breeding
- Define dominant as an allele that is expressed if it is present
- Define recessive as an allele that is only expressed when there is no dominant allele of the gene present
- Interpret pedigree diagrams for the inheritance of a given characteristic
- Use genetic diagrams to predict the results of monohybrid crosses and calculate phenotypic ratios, limited to 1:1 and 3:1 ratios
- Use Punnett squares in crosses which result in more than one genotype to work out and show the possible different genotypes

Extended

- Explain how to use a test cross to identify an unknown genotype
- Explain co-dominance by reference to the inheritance of ABO blood groups – phenotypes being A, B, AB and O blood groups and alleles being I^A, I^B and I^o
- Define a sex-linked characteristic as a characteristic in which the gene responsible is located on a sex chromosome and that this makes it more common in one sex than in the other
- Describe colour blindness as an example of sex linkage
- Use genetic diagrams to predict the results of monohybrid crosses involving co-dominance or sex linkage and calculate phenotypic ratios

17.1 INHERITANCE and 17.2 CHROMOSOMES, GENES AND PROTEINS

1. Define the following

Inheritance

Gene

Chromosome

Allele

2. Complete the sentences below about chromosomes and genes

Humans have a total of _____ chromosomes in their cells: _____ from their mother and the same amount from their father. This means we each have 2 _____ for each characteristic.

3. Cells with two sets of DNA are known as "diploid". Complete the table.

Type of cell	Number of chromosomes in humans	Ploid word
Most normal body cells		Diploid
Sex cells		

4. Complete the sentences below about DNA

DNA is string of information. Each single unit of the string is called a _____, but it takes three of these to code for a single _____. A chunk of three bases is called a _____.

The specific order of the bases decides which _____ _____ will be added in the sequence, and this determines which _____ the gene codes for.

5. Draw a diagram to show how the stages of protein synthesis (making protein). You must include DNA, mRNA, ribosomes and amino acids in your diagram.

1. Gene copied from DNA to mRNA	2. mRNA moves from the nucleus to ribosomes in the cytoplasm
3. Ribosomes join amino acids based on the code (using tRNA)	4. A complete string of amino acids is now a protein.

5. There are an estimated 20,000 genes in human skin cells. Using that information, estimate the number of genes in human nerve cells. Explain your answer.

17.3 MITOSIS

1. Define mitosis

2. State 3 reasons for mitosis in humans

i. _____

ii. _____

iii. _____

3. State one other reason for mitosis (one that does not apply to humans)

4. One student says:

"During mitosis, your cells split in half, so every time your cells divide you get two cells with half as any chromosomes"

Explain what is wrong with this statement:

5. Stem cells are unspecialized cells. Explain what this means.

17.4 MEIOSIS

1. Define meiosis

2. A student is very confused about cell division! Look at their statement below and make corrections. There are 5 errors.

"Egg and sperm cells, known as gametes, are formed by mitosis, meaning these cells are diploid. When the nucleuses of these cells fuse during fertilization, the newly formed zygote has 92 chromosomes. The zygote is tetraploid: it has double the number of chromosomes that the mother and father."

3. Explain how meiosis results in genetic variation

17.5 MONOHYBRID INHERITANCE

1. Match the words to the definitions

Genotype	having two identical alleles of a particular gene
Phenotype	the genetic make-up of an organism in terms of the alleles present
Homozygous	the observable features of an organism
Heterozygous	an allele that is expressed if it is present
Dominant	having two different alleles of a particular gene
Recessive	as an allele that is only expressed when there is no dominant allele of the gene present

2. A particular species of flower has one gene that determines the petal colour. It has 2 alleles for that gene, one codes for yellow and the other codes for red.

If a flower of that species has both of these alleles, it will appear red.

Decide on symbols for these alleles and state which is dominant and which is recessive

Colour	Allele symbol	Dominant/recessive?
Red		
Yellow		

3. Complete the genetic diagram to show the possible offspring that can be produced by crossing two parents that are heterozygous for the petal colour gene.

Parents genotypes: _____ _____

Gametes:

Offspring genotypes:

_____ _____ _____ _____

Phenotype:

_____ _____ _____ _____

4. The same plant has one gene the codes for height, with two alleles, " T " and " t", which code for tall or short plants respectively. Tallness is dominant to shortness in this plant.
Use Punnett square diagrams to determine the likeliness that the offspring will be tall in each of the following examples, as well as the phenotypic ratios.

a) Parents each with genotype Tt

	T	t
T	TT	
	Tall	
t		

Probability offspring is tall = _____%

Phenotypic ratio (tall:short) = _____

b) Two homozygous tall parents

Probability offspring is tall = _____%

Phenotypic ratio (tall:short) = _____

c) Two short parents

Probability offspring is tall = _____%

Phenotypic ratio (tall:short) = _____

5. The pairings in Q4b and c are examples of "pure-breeding". State what this means.

6. Use a genetic diagram to prove that the probability of producing a boy or a girl is 50:50.

7. Explain what is meant by "co-dominance"

8. The alleles for blood group show co-dominance. Alleles A and B are codominant but O is recessive.

State the phenotype of individuals with the following genotype:

Genotype	Phenotype
I^AI^A	
I^AI^B	
I^BI^B	
I^Ai^o	
I^Bi^o	
i^oi^o	

9. Blood type genes are an example of co-dominance. Draw a genetic diagram to find the phenotypic ratio of potential blood groups in the offspring based on the following parental genotypes.

a) Parents I^AI^A x I^Ai^o

b) Parents I^Ai^o x I^Bi^o

TEST CROSSES

1. Imagine a plant that you know has a gene that determines its height, with alleles "T" and "t" (tall and short, short is recessive). You take an individual from the species that is tall.

What are the possible genotypes of this plant?

2. Complete the genetic diagrams to show the possible results of crossing this individual with one that is short (remember, it's easy to figure out the genotype of the short plant).

a) Take a guess that the individual being testing is heterozygous

b) Take a guess that the individual being testing is homozygous

3. Describe an experiment you could carry out to find out the genotype of this particular plant. Use bullet points to structure your instructions.

SEX LINKAGE

1. Some traits are said to be "sex-linked". What chromosome might the genes for these traits found on?

2. How many versions of a sex-linked gene are present in our cells?

3. Colour blindness is a sex-linked trait. It is caused by a gene present on the X chromosome.
Draw a genetic diagram to show the ratio of possible phenotypes of the offspring, assuming neither parent suffers from colour blindness, but the mother is a carrier. Use symbols X^B, X^b and Y

Possible phenotypes: _____

Phenotypic ratio: _____