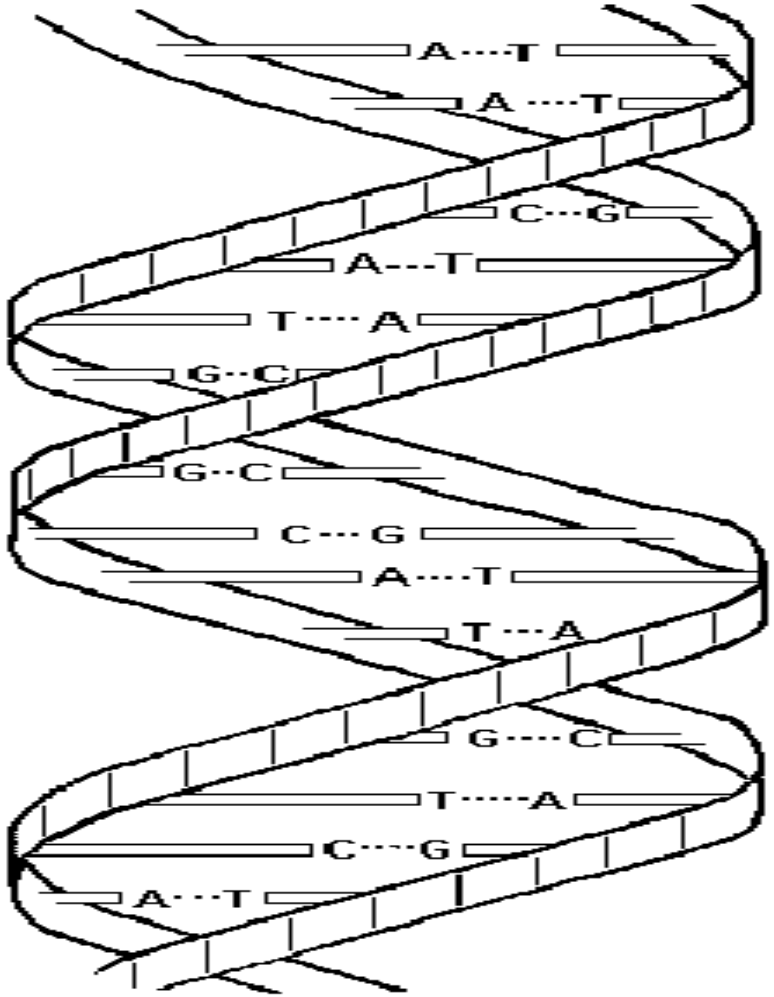
JUNE 2024: EXAM PREPARATION – PAPER 2

Life Sciences



How to Prepare for P2

- FOLLOW THE EXAM GUIDELINES
- REVISE EACH TOPIC MENTIONED BELOW
- TEST YOURSELF BY DOING PAST PAPER QUESTIONS
- MARK YOUR ANSWERS – USE MARKING GUIDELINES

- BE SPECIFIC IN THE WAY YOU ANSWER QUESTIONS
- SEE HOW MARKS ARE ALLOCATED

- FORM SUPPORT GROUPS
- GET A REASON WHY YOU WANT TO DO WELL

TOPICS COVERED IN PAPER 2

- **DNA – Code of Life**
- **Meiosis**
- **Genetics and Inheritance**
- **Scientific Investigation Skills**

FORMAT and MARK ALLOCATION

SECTIONS	TYPE OF QUESTIONS	MARKS
A	A variety of short answer questions: Objective questions for example MCQ, Terminology, Columns/statement and items, Data-response	50
B	A variety of question types. 2 questions of 50 marks each divided into 2 - 6 subsections	2 x 50
	TOTAL	**150**

DNA: The Code of Life

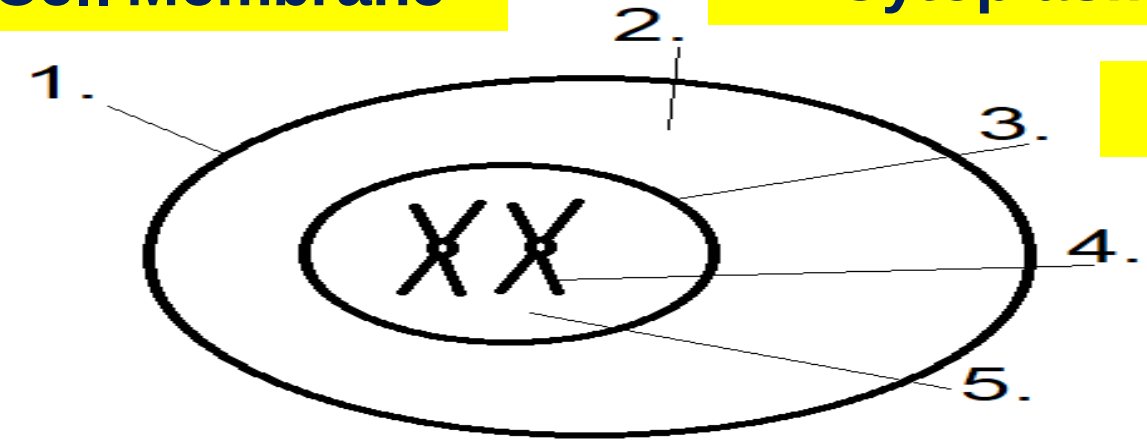
How do the following concepts relate?

- Cell
- Nucleus
- Chromosomes
- Chromatids
- DNA
- Nucleotides
- Genes

DNA: The Code of Life

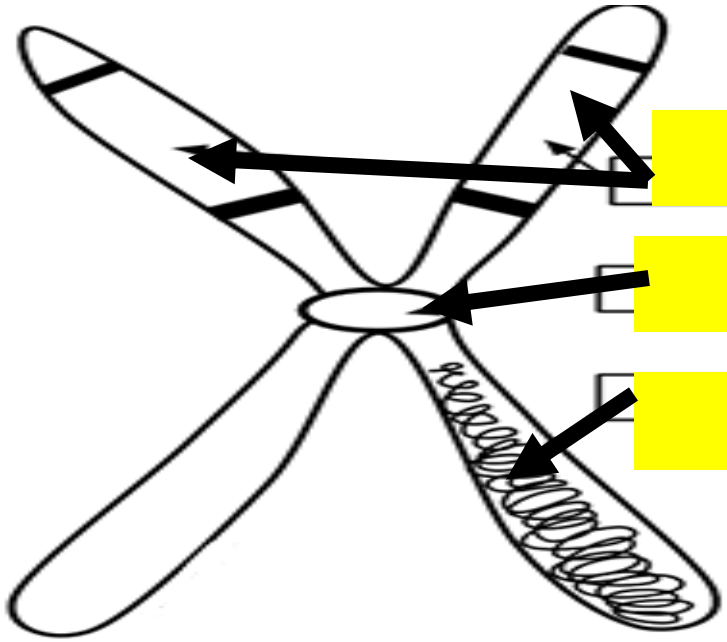
Cell Membrane

Cytoplasm



Nucleus

Chromosome

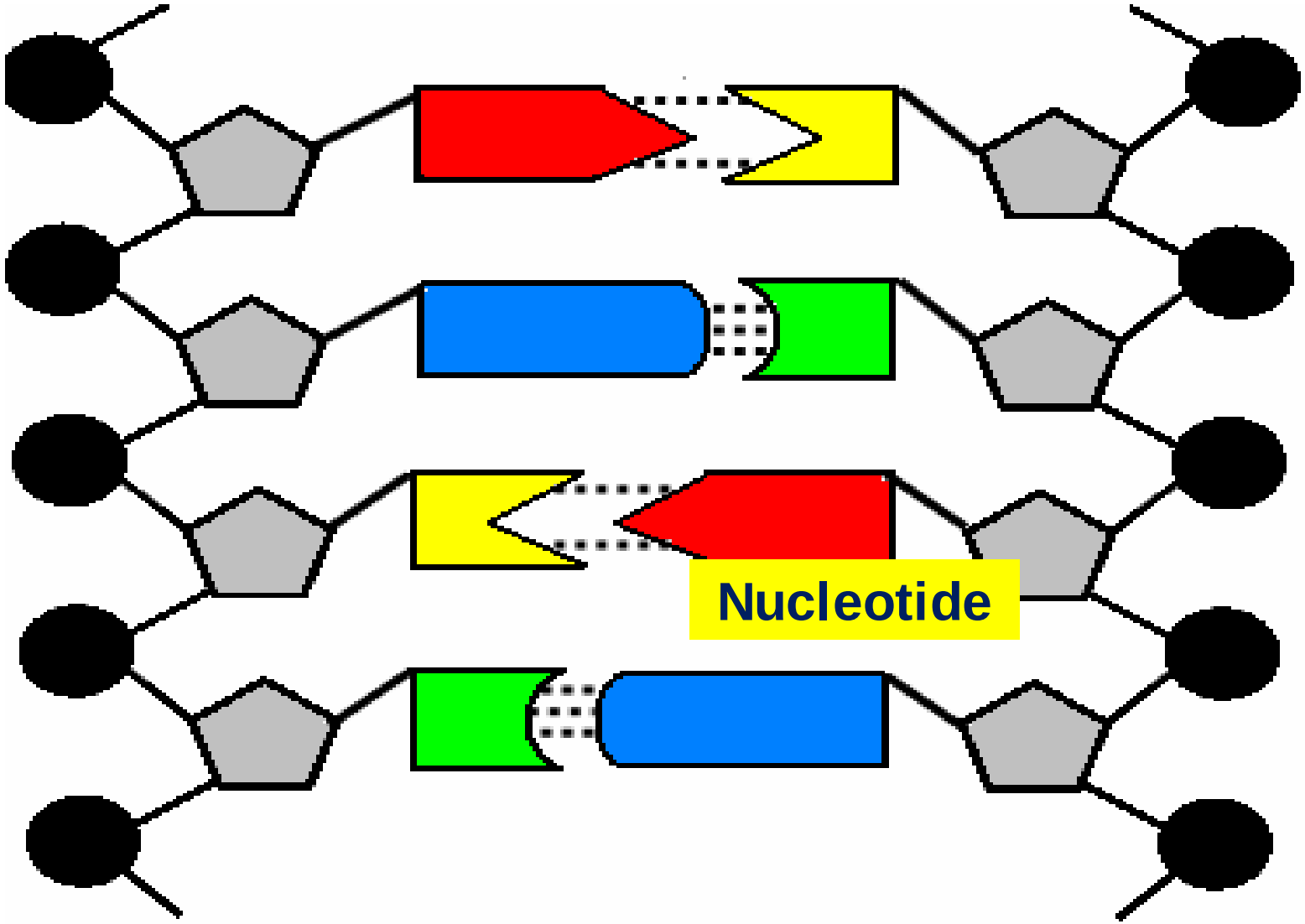


Chromatids

Centromere

DNA

DNA Structure



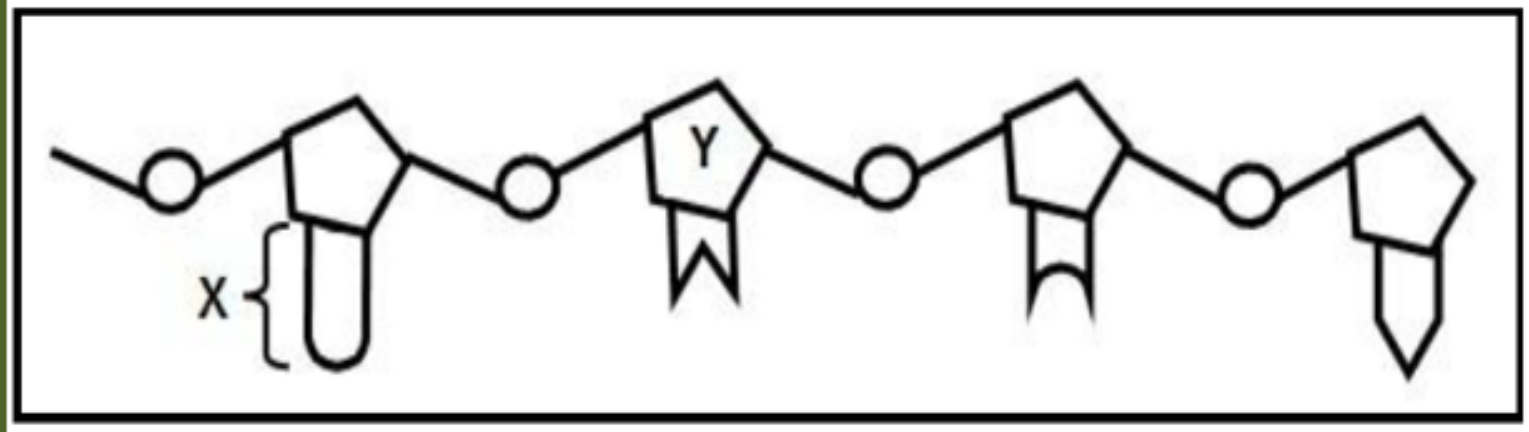
QUESTIONS ON DNA

1.1.6 A sample of DNA has 60 guanine bases and 30 adenine bases. How many phosphate molecules would you expect in this sample of DNA?

A 30
B 90
C 180
D 270

QUESTIONS ON DNA & RNA

The diagram below represents a single-stranded nucleic acid found in the nucleus.



2.1.1 Identify the nucleic acid in the diagram above. (1)

2.1.2 Name ONE organelle in the cytoplasm of a human cell where this nucleic acid is found. (1)

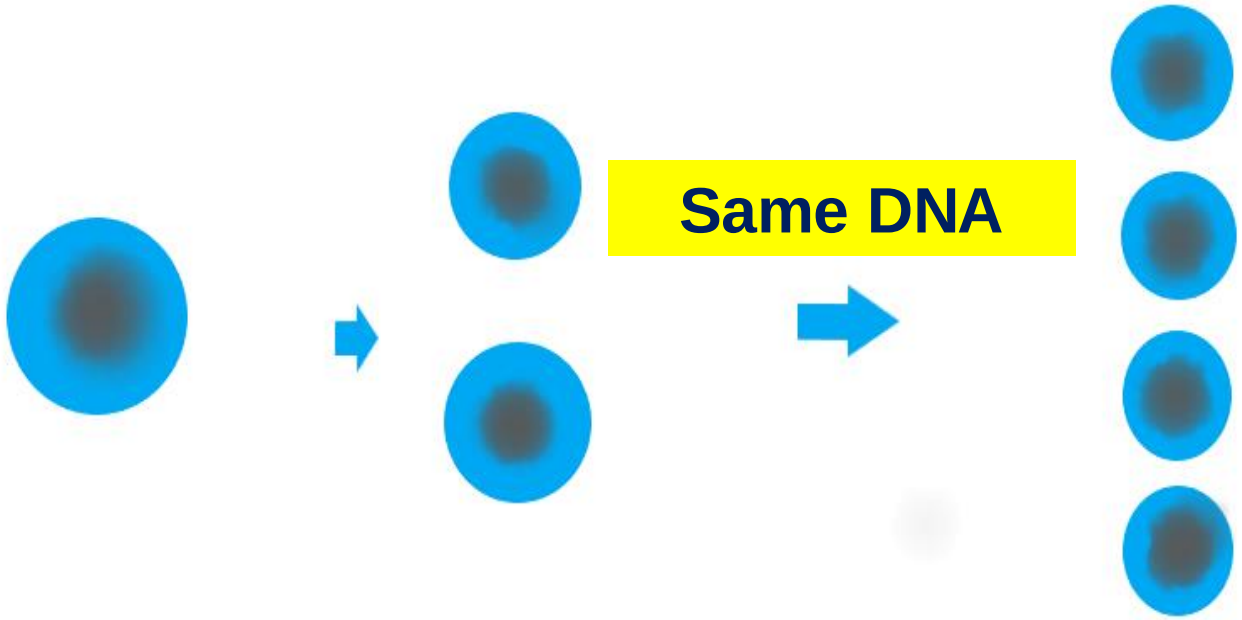
2.1.3 Identify the structures marked X and Y in the diagram. (2)

DNA: The Code of Life

DNA REPLICATION

Why?

When?



Describe DNA Replication

- With cell division - New cells require exact copies of the DNA as it is in the mother cell.

  Step 1: DNA unwinds, becomes ladder-shaped.

  Step 2: Weak H-bonds break, DNA molecule unzips.

  Step 3: Each strand forms a complementary strand for itself - Nucleotides attach G - C and A - T

  Step 4: Each strand becomes a double helix.

  The end result is TWO identical DNA molecules.

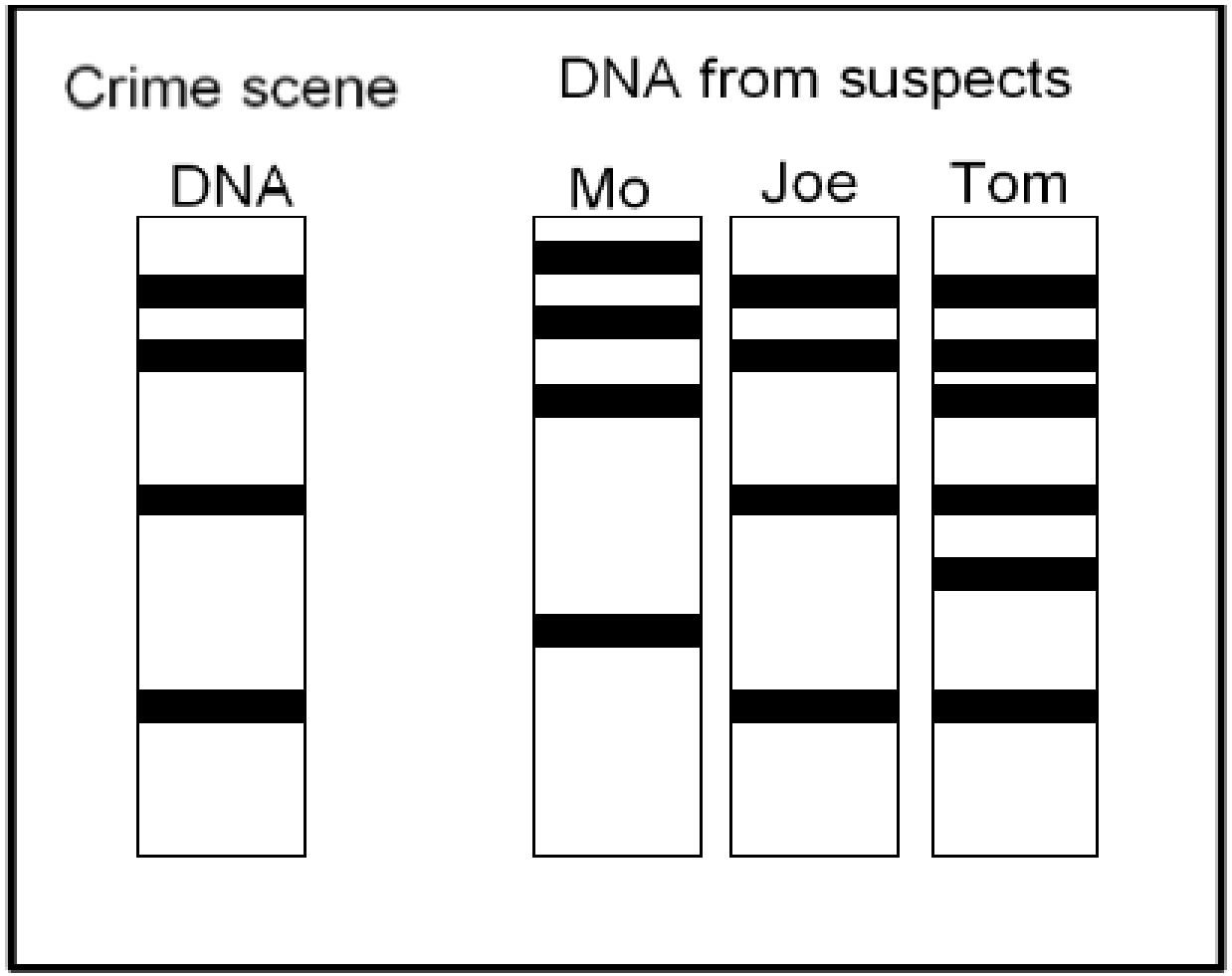
- Sometimes *mistakes* happen – ***mutation***

DNA: THE CODE OF LIFE

DNA	RNA
Double strand	Single strand
Deoxyribose sugar	Ribose sugar
Thymine	Thymine replaced by **Uracil**

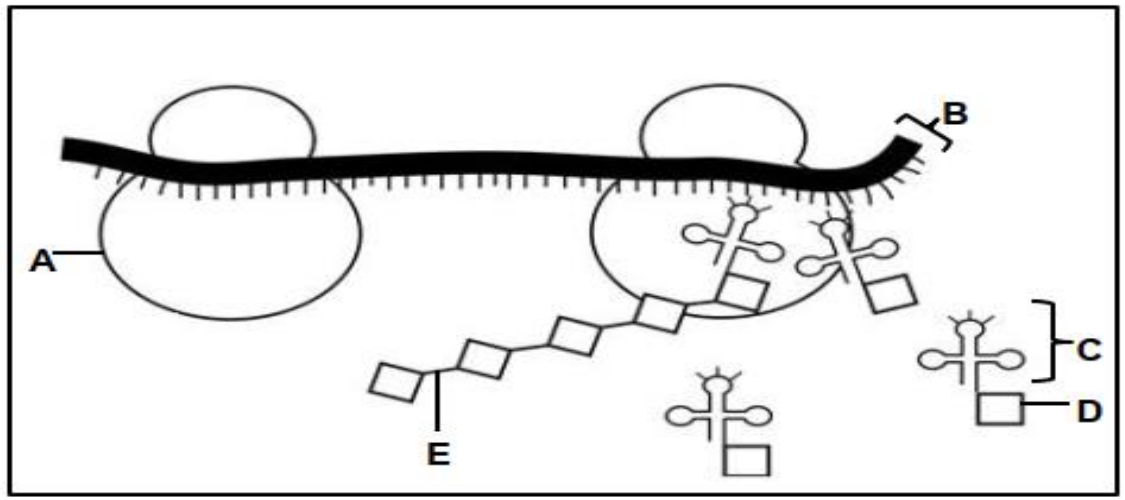
DNA: THE CODE OF LIFE

DNA PROFILE – Uses?



Protein Synthesis

6.3 The diagram represents a process during protein synthesis.



6.3.1 Identify the process above. (1)

6.3.2 Identify:

(a) Organelle **A** (1)

(b) Molecule **B** (1)

(c) The bond at **E** (1)

Protein Synthesis

The involvement of DNA and RNA in protein synthesis:

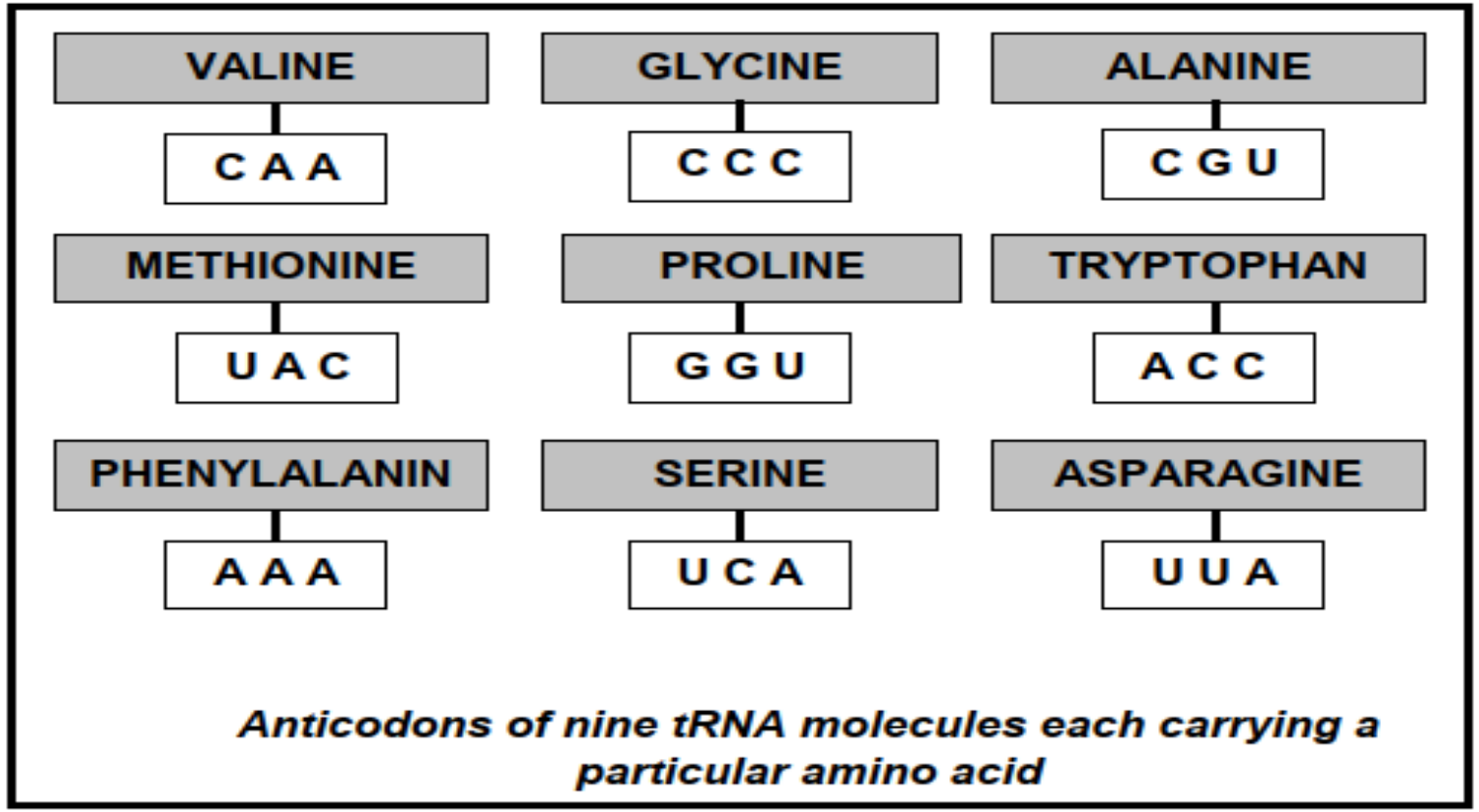
- Transcription
  - The double helix DNA unwinds.
  - The double-stranded DNA unzips/weak hydrogen bonds break to form two separate strands.
  - One strand is used as a template
  - to form mRNA
  - using free RNA nucleotides from the nucleoplasm.
  - The mRNA is complementary to the DNA.
  - mRNA now has the coded message for protein synthesis.
- mRNA moves from the nucleus to the cytoplasm and attaches to the ribosome.

Protein Synthesis

- Translation
  - Each tRNA carries a specific amino acid.
  - When the anticodon on the tRNA
  - matches the codon on the mRNA
  - then tRNA brings the required amino acid to the ribosome.
  - (Names of specific codons, anticodons and their amino acids are not to be memorised.)
  - Amino acids become attached to each other by peptide bonds
  - to form the required protein.

Protein Synthesis

1.5 The following diagram shows the anticodons of nine different tRNA molecules each carrying a particular amino acid



Anticodons of nine tRNA molecules each carrying a particular amino acid

1.5.1 Select and write down from the diagram above the amino acids (in the correct sequence) that would be required for the base sequence of mRNA shown below. (3)

UUU	GUU	AUG

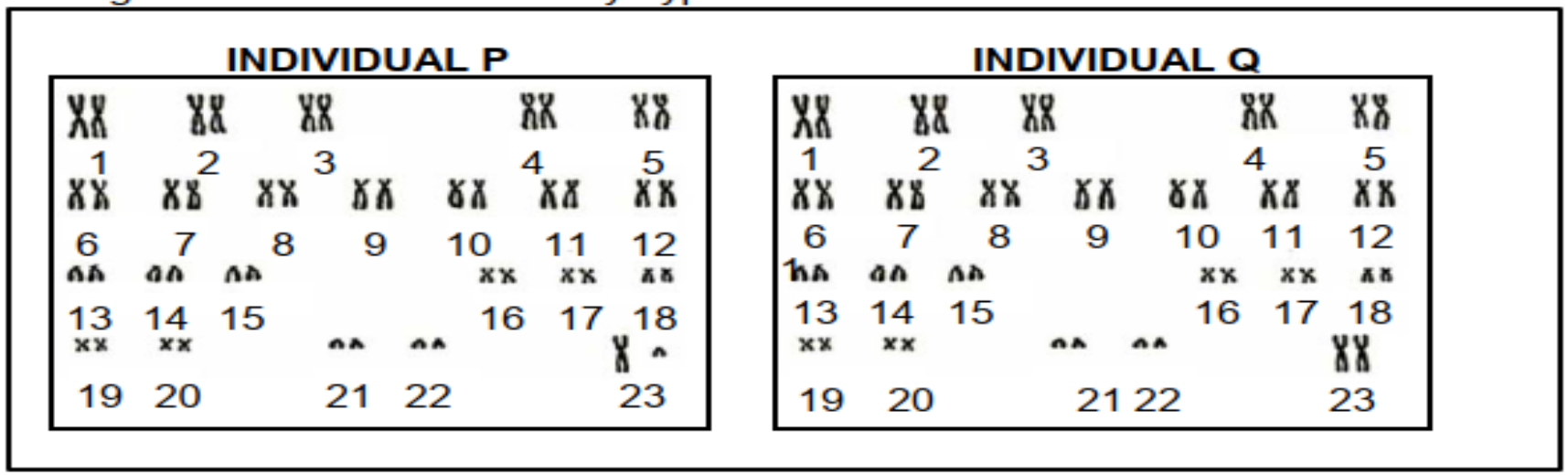
Meiosis

Key Concepts

- Compare Meiosis to Mitosis
- Autosomes and Gonosomes
- Chromosome numbers
- Importance of Meiosis
- Abnormal Meiosis
- 8 Phases of Meiosis – Identify, Label and Describe
- How Meiosis Contributes to Variation

Meiosis: Chromosome Numbers

4.7 The diagram below shows the karyotypes of two individuals.



4.7.1 What term is given to the chromosomes numbered:

(a) **1** to **22** (1)

(b) **23** (1)

4.7.2 State the gender of individual **P**. (1)

4.7.3 Give ONE observable reason for your answer to QUESTION 4.7.2. (2)

4.7.4 Each of the pairs shown is a homologous pair of chromosomes.

State the origin of each chromosome in a homologous pair of chromosomes. (2)

(7)

Meiosis: Chromosome Numbers - Answers

4.7 4.7.1 (a) Autosomes✓ (1)

(b) Gonosomes✓ /sex chromosomes (1)

4.7.2 Male✓ (1)

4.7.3 - There is a Y-chromosome✓/XY chromosomes
-at chromosome pair 23✓ (2)

4.7.4 One comes from the male parent✓ and the other comes from the female parent✓

OR

One comes from the sperm✓ and the other comes from the ovum✓ (2)

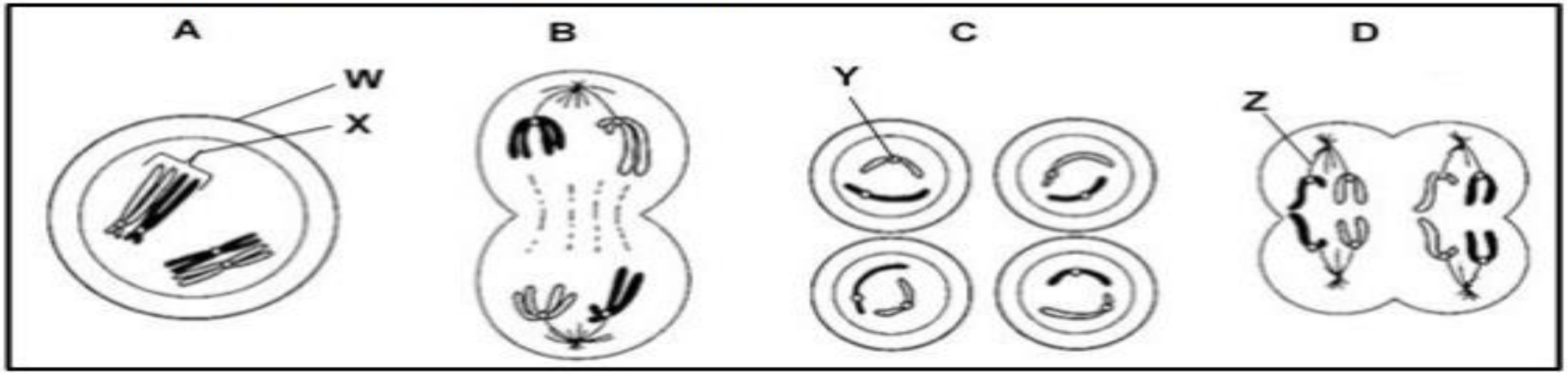
(7)

Importance of Meiosis

- The importance of meiosis:
  - Production of haploid gametes
  - The halving effect of meiosis overcomes the doubling effect of fertilisation, thus maintaining a constant chromosome number from one generation to the next
  - Mechanism to introduce genetic variation through:
    - Crossing over
    - The random arrangement of chromosomes at the equator

Phases of Meiosis

4.4 The diagrams below show different phases in meiosis.



4.4.1 Label the structures **W** and **X**. (2)

4.4.2 How many chromosomes are present in each cell in:

(a) Phase **A** (1)

(b) Phase **C** (1)

4.4.3 Give only the LETTER of the diagram that represents anaphase II. (1)

4.4.4 State the function of structure **Y** and structure **Z**. (2)

4.4.5 Identify phase **C**. (1)

(8)

Phases of Meiosis - Answers

4.4.1 W Cell membrane ✓/ Plasmalemma (1)

X Homologous chromosomes✓/Bivalent (1)

4.4.2 (a) 4✓ (1)

(b) 2 ✓ (1)

4.4.3 D✓ (1)

4.4.4 Y Holds the sister chromatids together✓

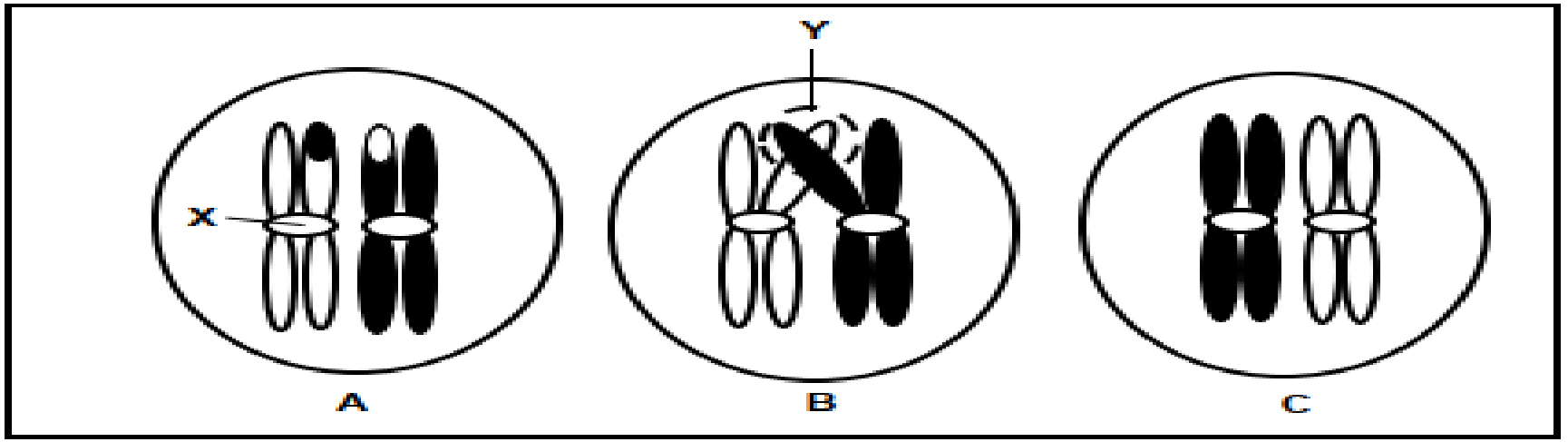
Z Pulls chromosomes/chromatids to the poles✓ (2)

4.4.5 Telophase II✓ (1)

(8)

Meiosis: Crossing Over in Prophase I

4.5 The diagrams below represent a chromosome pair in a female human cell. The cells (**A**, **B** and **C**) show different events in a phase of meiosis, which are not necessarily in the correct sequence.



4.5.1 How many pairs of chromosomes occur in a normal human cell? (1)

4.5.2 Give labels for:

(a) Structure **X** (1)

(b) Area **Y** (1)

4.5.3 Name the organ in the human female where meiosis occurs. (1)

4.5.4 Name the:

(a) Process occurring in diagram **B** (1)

(b) Phase represented by the diagrams above (1)

Crossing Over: Answers

4.5 4.5.1 23✓

4.5.2 (a) Centromere✓

(b) Chiasma✓/chiasmata

4.5.3 Ovary✓

4.5.4 (a) Crossing over✓

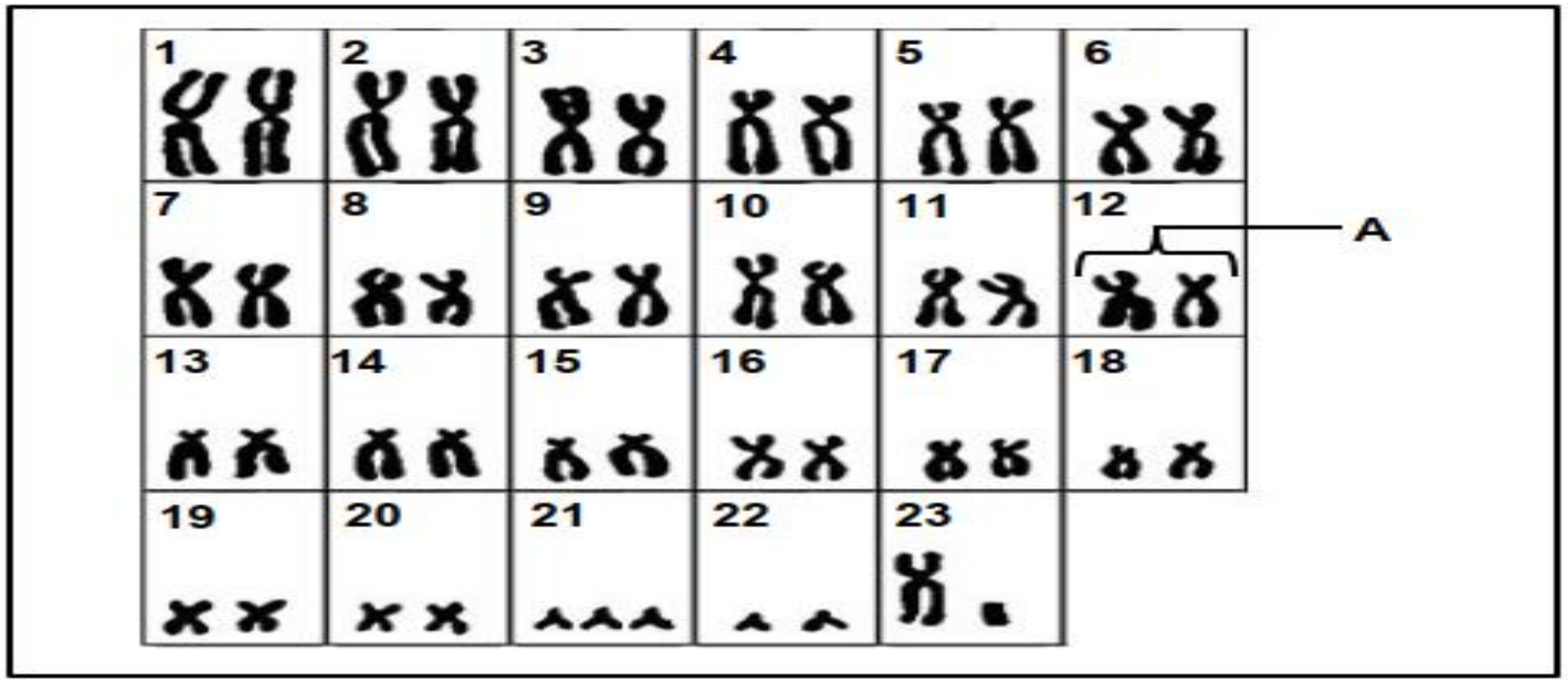
(b) Prophase I✓

(c) ova✓/gametes/sex cells

4.5.5 C→ B→ A✓(correct sequence)

Abnormal Meiosis: Down Syndrome

The karyotype below shows the chromosomes of a person with Down syndrome.



4.3.1 Give the label for **A**. (1)

4.3.2 How many autosomes are there in a nucleus of this cell? (1)

4.3.3 Name the type of chromosomes at position **23**. (1)

4.3.4 What evidence suggests that this is a karyotype of a male? (1)

4.3.5 Name the type of mutation represented in the diagram. (1)

4.3.6 Describe the events that led to Down syndrome. (6)

What Leads to Down Syndrome?

- Non-disjunction occurred✓/A homologous pair of chromosomes failed to separate
- at position 21✓
- during Anaphase✓
- resulting in one gamete with 24 chromosomes✓/an extra chromosome/2 chromosomes at position 21
- The fertilisation of this gamete with a normal gamete✓/gamete with 23 chromosomes/1 chromosome at position 21
- results in a zygote with 47 chromosomes✓
- There are 3 chromosomes✓/an extra chromosome at position 21/ this is Trisomy 21

Any 6

Down Syndrome - Answers

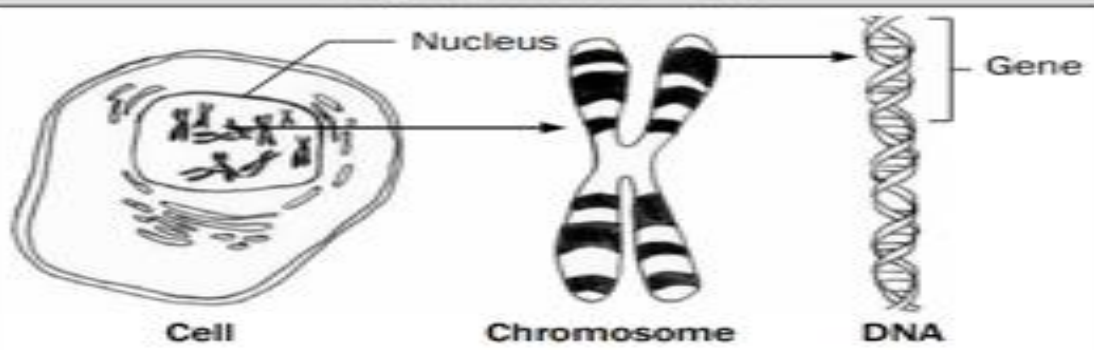
4.2	4.2.1	(a) 46✓ (b) 44✓ (c) 2✓
	4.2.2	23✓
	4.2.3	Male✓
4.3	4.3.1	Homologous chromosomes✓
	4.3.2	45✓
	4.3.3	Gonosomes✓
	4.3.4	The presence of a Y chromosome✓/XY chromosome
	4.3.5	Chromosome✓mutation

Genetics and Inheritance

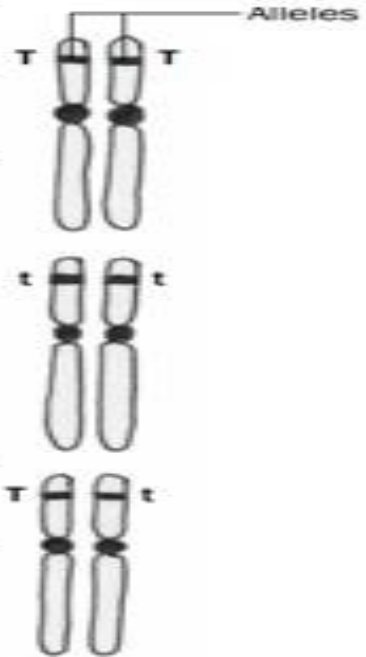
Key Concepts

- Terminology
- Mendel’s Law of (1) Dominance & (2) Segregation
- Determination of Gender
- Types of Dominance
- Blood Groups
- Gender Related Problems
- Dihybrid Crosses
- Pedigree Diagrams
- Mutations
- Genetic Engineering

Genetics: Terminology

Term	Explanation	Diagram/Additional notes
Gene	A small portion of DNA coding for a particular characteristic.	
Alleles	Different forms of a gene which occur at the same locus (position) on homologous chromosomes.	**Dominant allele (T) – tall plant** **Recessive allele (t) – short plant**

Genotype	Genetic composition (make-up) of an organism.
Phenotype	The physical appearance of an organism determined by the genotype, e.g. tall, short.
Dominant allele	An allele that is expressed (shown) in the phenotype when found in the heterozygous (Tt) and homozygous (TT) condition.
Recessive allele	An allele that is masked (not shown) in the phenotype when found in the heterozygous (Tt) condition. It is only expressed in the homozygous (tt) condition.
Heterozygous	Two different alleles for a particular characteristic, e.g. Tt.
Homozygous	Two identical alleles for a particular characteristic, e.g. TT or tt.



- Homozygous dominant (both alleles are dominant)
- Genotype TT
- Phenotype – tall

- Homozygous recessive (both alleles are recessive)
- Genotype tt
- Phenotype – short

- Heterozygous (one dominant and one recessive allele)
- Genotype Tt
- Phenotype – tall

Genetics: Terminology

Monohybrid cross	Only one characteristic or trait is being shown in the genetic cross.	*Example:* Flower colour only, e.g. yellow flower or white flower **OR** shape of seeds only, e.g. round seeds or wrinkled seeds.	
Complete dominance	A genetic cross where the dominant allele masks (blocks) the expression of a recessive allele in the heterozygous condition.	In this type of cross the allele for tall (T) is dominant over the allele for short (t). The offspring will therefore **be tall** because the dominant allele (T) masks the expression of the recessive allele (t).	Tall (TT) × short (tt) Tall (Tt)
Incomplete dominance	A genetic cross between two phenotypically different parents produces offspring different from both parents but with an intermediate phenotype.	*Example:* If a red-flowered plant is crossed with a white-flowered plant and there is incomplete dominance – the offspring will have **pink flowers (intermediate colour)**.	Red flower – White flower Pink flowers
Co-dominance	A genetic cross in which both alleles are expressed equally in the phenotype.	*Example:* If a red-flowered plant is crossed with a white-flowered plant and there is co-dominance the offspring has **flowers with red and white patches**.	Red flower × White flower Flowers with red and white patches
Multiple alleles	More than two alternative forms of a gene at the same locus.	*Example:* Blood groups are controlled by three alleles, namely I^A, I^B and i.	

Sex-linked characteristics	Characteristics or traits that are carried on the sex chromosomes.	*Examples:* Haemophilia and colour-blindness The alleles for haemophilia (or colour-blindness) are indicated as superscripts on the sex chromosomes, e.g. X^HX^H (normal female), X^HX^h (normal female), X^hX^h (female with haemophilia), X^HY (normal male), X^hY (male with haemophilia).
Karyotype	The number, shape and arrangement of all the chromosomes in the nucleus of a somatic cell.	
Cloning	Process by which genetically identical organisms are formed using biotechnology.	*Example:* Dolly the sheep was cloned using a diploid cell from one parent; therefore it had the identical genetic material of that parent.
Genetic modification	The manipulation of the genetic material of an organism to get desired changes.	*Example:* The insertion of human insulin gene in plasmid of bacteria so that the bacteria produce human insulin.
Human genome	The mapping of the exact position of all the genes in all the chromosomes of a human.	*Example:* Gene number 3 on chromosome number 4 is responsible for a particular characteristic.

2 Laws of Mendel

The Law of Dominance-

- When two homozygous organisms with contrasting characteristics are crossed, all the individuals of the F_1 generation will display the dominant trait
- An individual that is heterozygous for a particular characteristic will have the dominant trait as the phenotype.

Mendel's Principle of Segregation –An organism possesses two 'factors' which separate or segregate so that each gamete contains only one of these 'factors'

Determination of Gender

Sex determination	▪ 22 pairs of chromosomes in humans are autosomes and one pair of chromosomes are sex chromosomes/gonosomes ▪ Males have XY chromosomes and females have XX chromosomes ▪ Differentiate between sex chromosomes (gonosomes) and autosomes in the karyotypes of human males and females ▪ Representation of a genetic cross to show the inheritance of sex

Genetics: Types of Dominance – Complete Dominance

5.2 In rabbits, black fur is produced by the allele (**B**) and white fur by the allele (**b**).

The table below shows the genotypes of some rabbits.

RABBIT	GENOTYPE
1	BB
2	Bb
3	bb

5.2.1 What is the phenotype:

(a) Produced by the recessive allele (1)

(b) Of rabbit **2** (1)

5.2.2 Give the NUMBER only (**1**, **2** or **3**) of the rabbit(s) that is/are:

(a) Pure-bred

(b) Homozygous dominant (3)

(5)

Types of Dominance – Incomplete Dominance

There is No Dominance – Use Capital Letters Only!

Eg Red Rose x White Rose gives Pink in F1

Breeders prefer to produce red roses. If the allele for red is **R** and the allele for white is **W**, which ONE of the following crosses would give the highest proportion of red roses?

A RR x WW
B RW x RW
C WW x RW
D RR x RW

Answer: D

Types of Dominance: Co-Dominance

Both Features are Expressed in the F1 Phenotype and are Equally Dominant.
Use Capital Letters Only!

Eg

P1: Brown Horse x White Horse gives Brown and White Patches in F1

Genotype: BB x WW gives BW in F1

Blood Groups: Between A & B there Is Co-Dominance (Group A x Group B) gives AB

THREE babies (**X**, **Y** and **Z**) from three different sets of parents were born in a hospital. TWO of the babies were accidentally swopped. Blood groups of the parents were used to establish which baby belonged to which set of parents.

The blood groups of the parents and the babies are shown in the table below.

PARENTS	BABIES	BLOOD GROUPS OF PARENTS AND BABIES		
		Mother	Father	Baby
Mr and Mrs Pule	X	B	A	A
Mr and Mrs Chaka	Y	AB	B	O
Mr and Mrs Tau	Z	O	B	AB

Which TWO babies (from **X**, **Y** and **Z**) were swopped? (2)

Give the surnames of the biological parents of the two babies that were swopped. Write the correct surnames of the parents next to the letter (**X**, **Y** or **Z**). (2)

Give the possible genotype(s) of Mr Pule that could have produced baby **X**. (2)

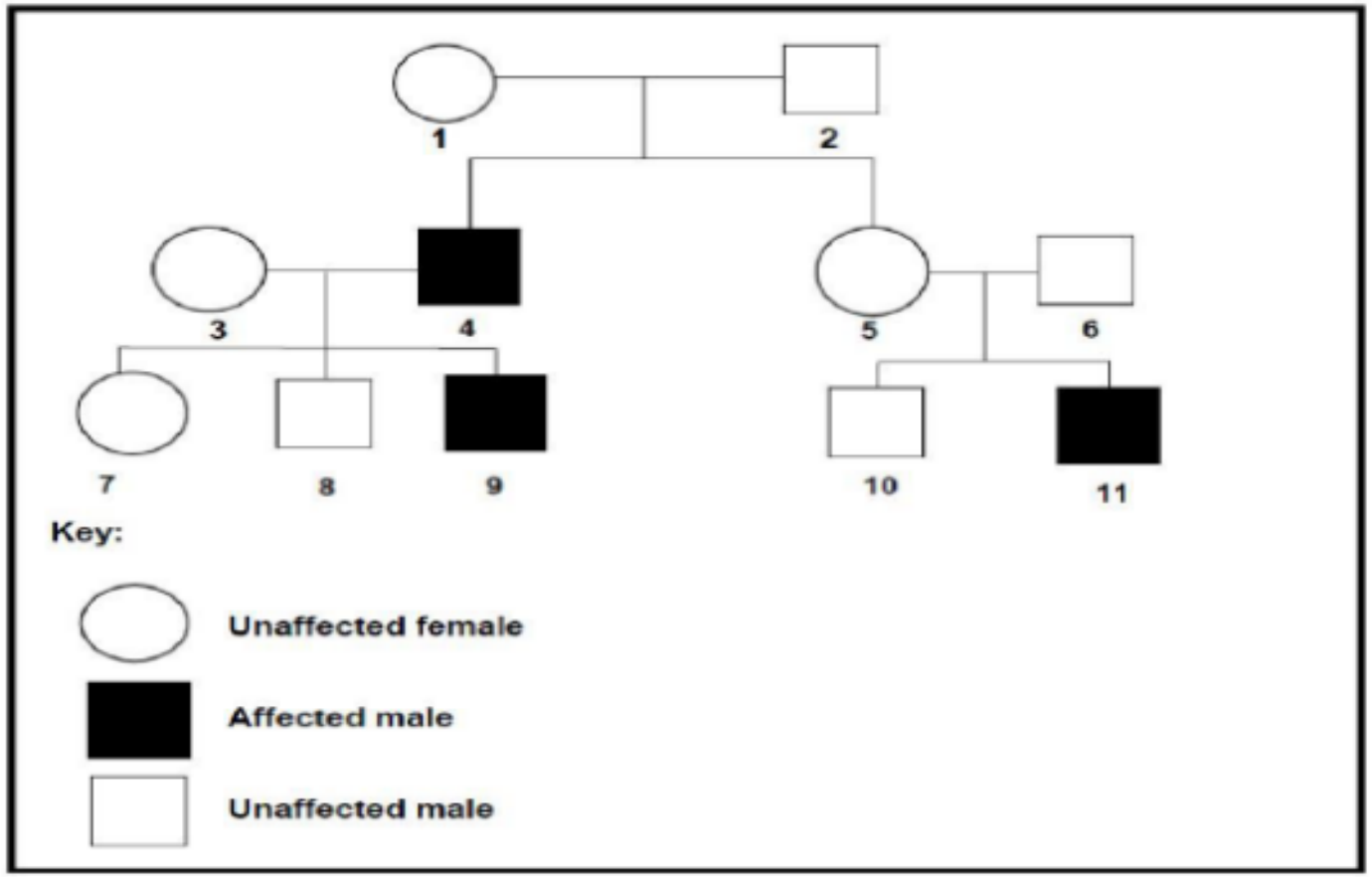
(6)

GENDER RELATED PROBLEMS

- **Haemophilia & Colour-Blindness**

Use X and Y

The pedigree diagram below traces the inheritance of haemophilia



GENDER RELATED PROBLEMS - Questions

How many family members not affected by haemophilia are carriers? (1)

Explain why this disorder affects mostly males in this family. (3)

Use the possible alleles X^H, X^h and Y to determine the genotype of the following:

(a) Individual 1 (2)

(b) Individual 4 (2)

What are the chances of individual 10 and his wife, who is a carrier (not shown in the pedigree), having a son who is affected? (2)

Give TWO reasons why individual 9 and his partner should undergo genetic counselling before starting a family. (2)

(12)

Dihybrid Crosses

In rice plants the allele for high yield (H) is dominant over the allele for low yield (h). The allele for a tall stem (T) is dominant over the allele for a short stem (t).

There are two varieties of rice plants, A and B.
The genotype of variety A is HHtt.
The genotype of variety B is hhTT.

A plant breeder wants to produce a rice plant variety with a high yield and a short stem.

5.3.1	Give the phenotype of variety A.	(2)
5.3.2	Give ALL the possible genotypes of the gametes of variety B.	(1)
5.3.3	Give the genotype(s) of the variety the plant breeder wants to produce.	(2)
5.3.4	Explain why the plant breeder would want to produce a rice plant with a short stem.	(1)
5.3.5	Describe how the plant breeder would be able to produce rice plants with a high yield and short stems only.	(2)
		(8)

Dihybrid Answers

5.3.1 High yield✓
Short stem✓ (2)

5.3.2 hT✓ (1)
(*Mark first ONE only*)

5.3.3 HHtt✓, Hhtt✓ (2)
(*Mark first TWO only*)

5.3.4 Does not break easily in windy conditions✓/to carry a bigger yield/ easier to harvest Any (1)

5.3.5 The plant breeder must cross✓ plants of variety A (HHtt) with plants of variety A✓(HHtt) (2)

(8)

Mutations

Definition of a mutation

Effects of mutations: harmful mutations, harmless mutations and useful mutations

Mutations contribute to genetic variation

Definition of gene mutation and chromosomal mutation

Genetic Engineering

- GMO's
- Stem Cells

- Cloning – Understand why and how it's done

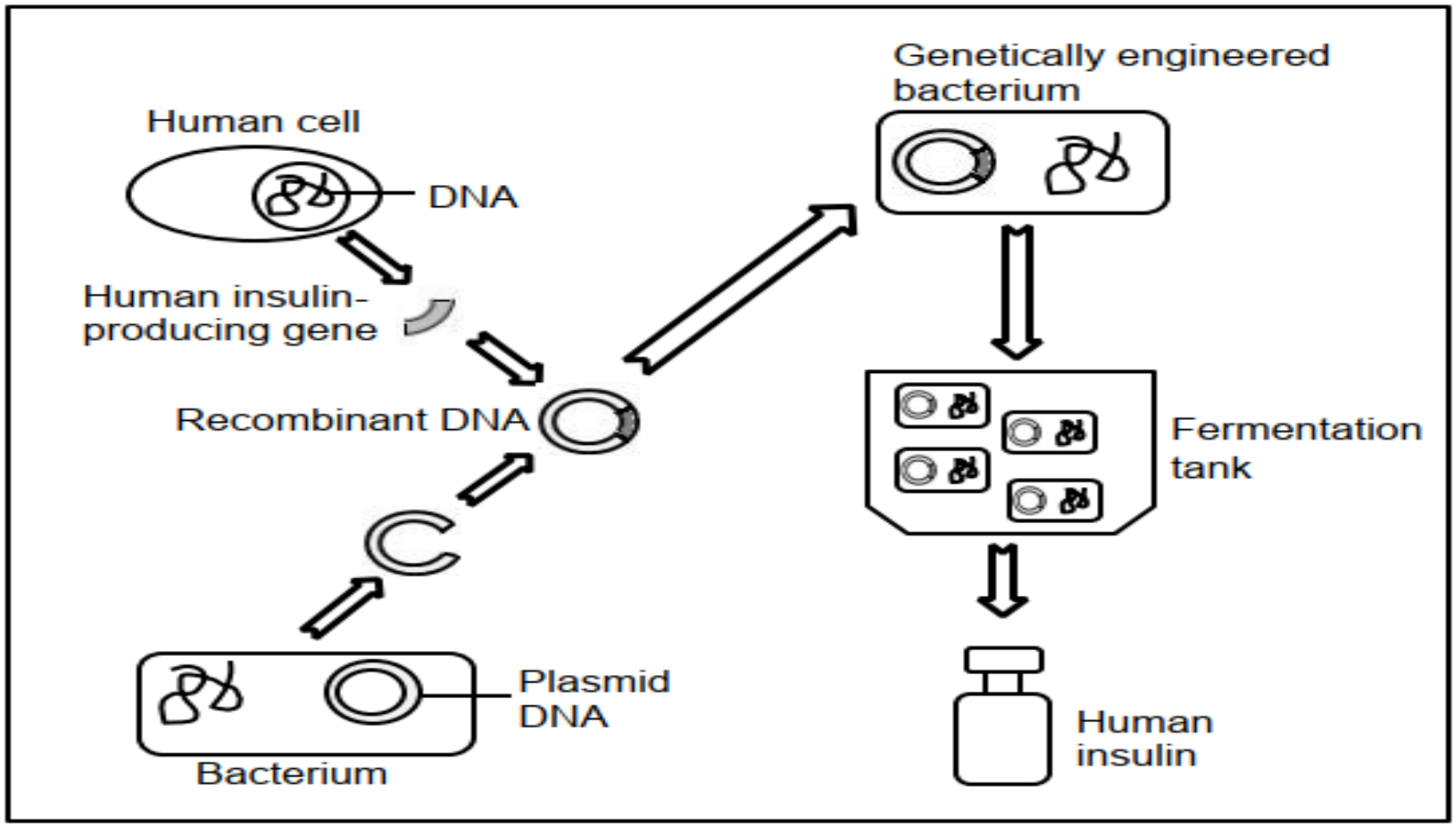
- What are GMO's? Any benefits or problems?

- Use of Stem Cells – How?

Genetic Engineering

Synthetic insulin is used to treat diabetes and is produced by genetic engineering technology.

The diagram below represents the process.



Genetic Engineering - Questions

Define *genetic engineering*. (2)

Describe the steps involved in producing the recombinant DNA. (4)

Explain why bacteria are most suitable for genetic engineering. (2)

Suggest THREE objections that some people might have to genetic engineering. (3)

(11)

Genetic Engineering - Answers

5.9.1 - The manipulation of genetic material✓
- to produce a genetically different✓/identical organism/repair tissues and organs

OR

-The manipulation of genetic material✓
-to produce something of benefit to humans✓/society (2)

5.9.2 - A plasmid/ circular DNA is removed from the bacterial cell✓
- It is cut✓ using enzymes
-The insulin gene is removed from a human cell✓ and
-inserted into the plasmid✓to form the recombinant DNA (4)

Genetic Engineering - Answers

5.9.3

- Bacteria reproduce very rapidly✓,
- forming many copies of the gene✓ in a short period of time

5.9.4

- Expensive✓/ research money could be used for other needs
- Interfering with nature✓/ immoral
- Potential health impacts✓
- Unsure of long-term effects✓

Any 3

Mitochondrial DNA

- **What is Mt-DNA**

- **The Value of Mutations in Mt-DNA to trace Maternal Ancestry**

Paternity Testing

- **Blood Groups**

  vs

- **DNA Profiling – More Accurate, Why?**

Be Successful in Life Sciences

- **Step 1**: Follow the Exam Guidelines
- **Step 2:** Revise the Material
- **Step 3**: Test Yourself by Using Past Papers

Best Wishes with Paper 2!