THE ANSWER SERIES *Your Key to Exam Success*

LIFE SCIENCES

SUMMARY & **TEACHING** TOOL

THE ANSWER SERIES *Your Key to Exam Success*

2023 LIFE SCIENCES NSC **PAPER 2**

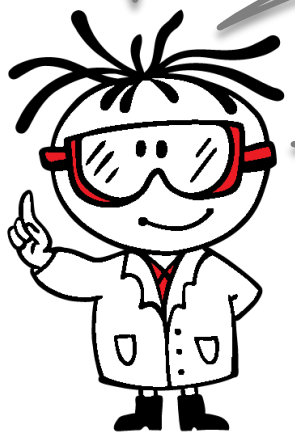
Life Sciences Paper 2

SUMMARY & **TEACHING** TOOL

Let's work through the paper and look at the problem areas as identified in the 2023 NSC Diagnostic Report.

Commentary from the Diagnostic Report is noted in grey blocks like the one below. Use these to guide discussions.

Candidates confused the centromere with the centrosome.



In some cases, revision or application options will be provided and can be identified by this symbol:

Let's revise this

Click to go to the specific section.

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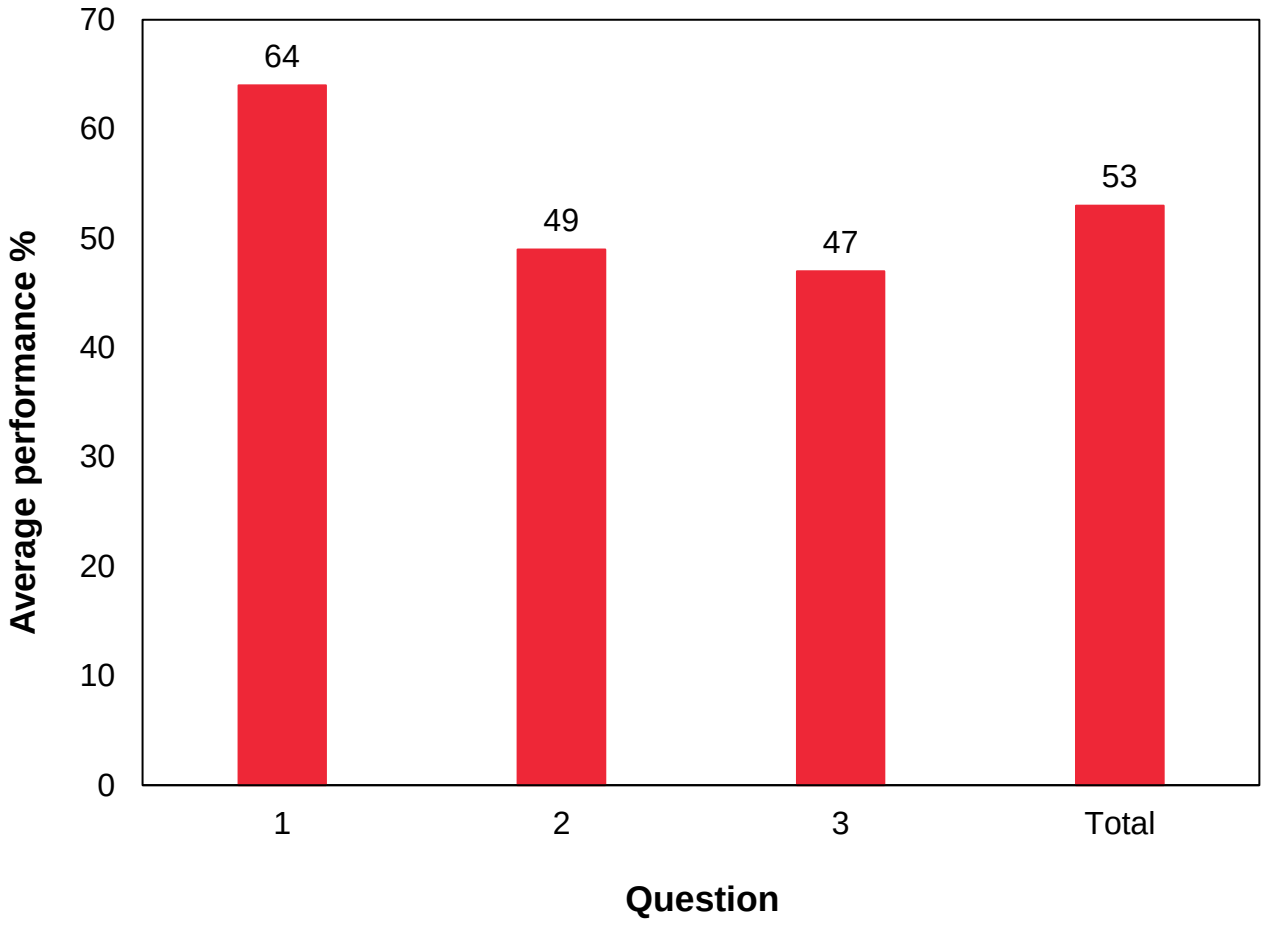
2023 LIFE SCIENCES NSC **PAPER 2**

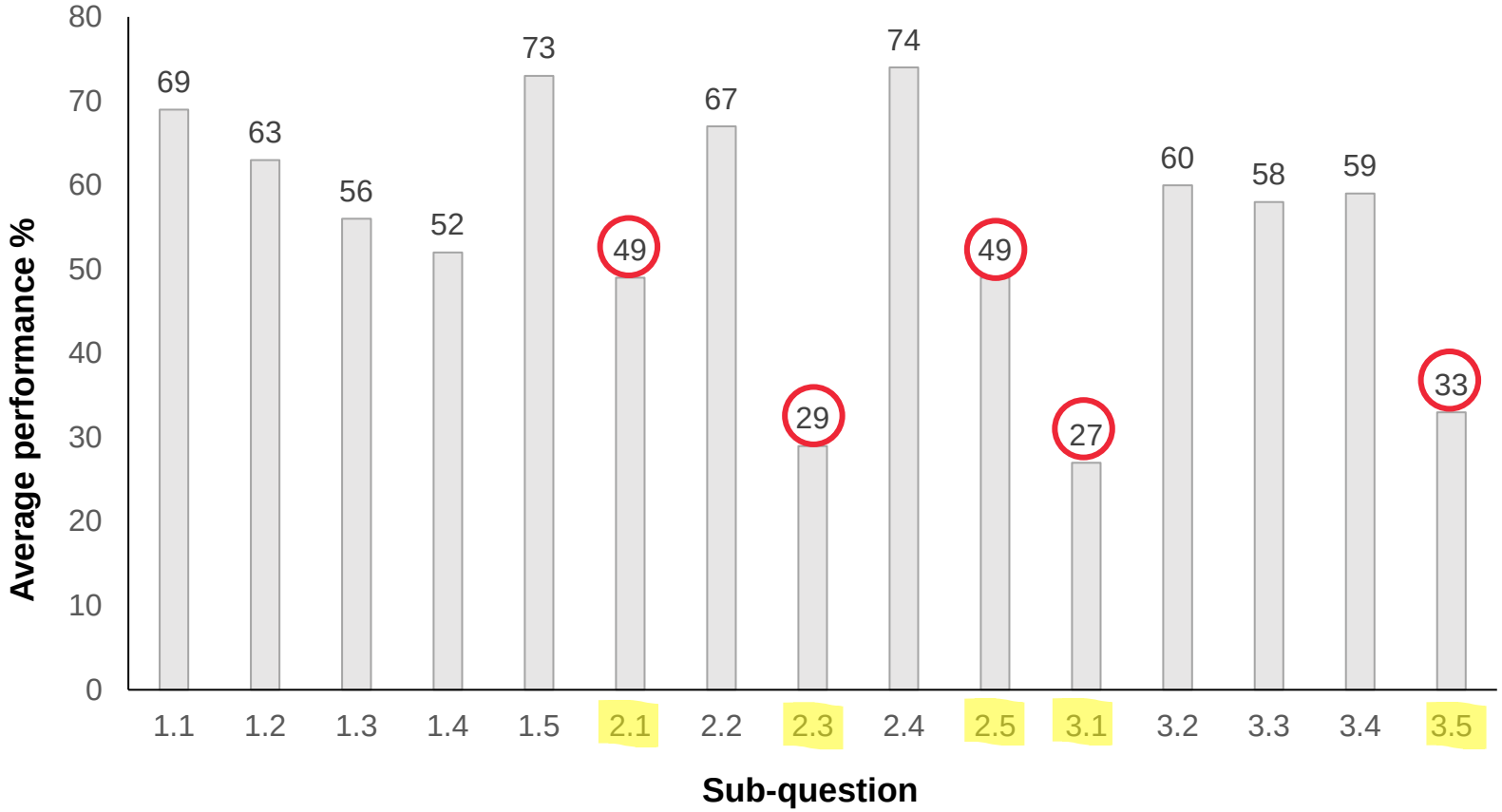
Average performance per question



Question	Topics
1	Multiple choice, Terminology, Matching items, Pedigree diagram (blood groups), Protein Synthesis
2	Meiosis, DNA Replication, Mutation on DNA, Monohybrid cross, Dihybrid cross
3	Artificial selection and Genetic engineering, Natural Selection, Scientific investigation (evolution), Phylogenetic tree, Human evolution

2023 LIFE SCIENCES NSC **PAPER 2**

Average performance per sub-question



Problem areas

2.1 Meiosis

2.3 Mutation on DNA

2.5 Dihybrid cross

3.1 Artificial Selection and Genetic Engineering

3.5 Human Evolution

2023 LIFE SCIENCES NSC **PAPER 2**

General Comments

! Correct **spelling** is very important

- *peptide bond✓ vs polypeptide bond✗*
- *double helix✓ vs double stranded helix✗*
- *chromatin network✓ vs chromatin✗*
- *reproduce✓ vs produce✗*
- *fertilisation✓ vs fusion✗*

! Emphasise difference between commonly **confused terms**

- *peptide bond vs polypeptide vs protein*
- *autosomes vs gonosomes*
- *phenotype vs genotype*
- *bivalent vs homologous chromosome pair*
- *desirable vs favourable characteristic*

Let's revise this

! Emphasise difference between commonly **confused processes**

- *complete vs co- vs incomplete dominance*
- *artificial selection vs genetic engineering*
- *chromosomal mutation vs gene mutation*

Let's revise these

! **Scientific investigations** still require attention

- *do not give generic answers, e.g. a large sample size was used*
- *give specific information for the investigation provided, e.g. a large sample of 150 volunteers/participants was used*

Revised in 2023 Paper 1 Diagnostic Report T & L Tool

2023 LIFE SCIENCES NSC **PAPER 2**

General Comments

- Understand how to perform **basic calculations**

  Revised in 2023 Paper 1 Diagnostic Report T & L Tool

- **Don't memorise** the **memoranda** of past papers
  - *scenarios differ each year*
  - *respond appropriately to the question in front of you*

- Read the **action verbs** to **indicate how much** needs to be **written**

- Understand **links between** Gr 12 content and **previous grades**, e.g.:
  - *thrombosis → artery blockage → less oxygen and nutrients transported (Gr 10)*
  - *transitional species (Gr 10)*
  - *scientific nomenclature (Gr 10)*

SECTION A – Multiple Choice

1.1.1 The base pairing in DNA was discovered by …

A Watson and Wilkins.
B Franklin and Wilkins.
C Franklin and Crick.
D Crick and Watson.

Grade 12 Life Sciences Part 2 p. 3 (2024 ed.)

1.1.2 A gene codes for the production of …

A a chromosome.
B an allele.
C DNA.
D a protein.

Grade 12 Life Sciences Part 2 p. 3 (2024 ed.)

1.1.3 Which ONE of the following is a characteristic of stem cells?

A They are easily obtained from any organ.
B They divide by meiosis.
C They are haploid.
D They can be stimulated to form any type of cell needed.

Grade 12 Life Sciences Part 2 p. 83 (2024 ed.)

1.1.4 The chances of having a female child in humans is …

A 25%
B 50%
C 75%
D 100%

Grade 12 Life Sciences Part 2 p. 60 (2024 ed.)

1.1.5 Which ONE of the following is part of the reason why colour-blindness is more common in males than in females?

A The allele for colour-blindness is recessive and located on the X-chromosome.
B Colour-blind males have two copies of the allele for colour-blindness.
C The allele for colour-blindness is recessive and located on the Y-chromosome.
D Fathers pass the allele of colour-blindness to their sons only.

Grade 12 Life Sciences Part 2 p. 63 (2024 ed.)

SECTION A – Multiple Choice

1.1.1 The base pairing in DNA was discovered by …

A Watson and Wilkins.
B Franklin and Wilkins.
C Franklin and Crick.
D Crick and Watson.

Candidates confused the scientists who discovered this specific aspect of the structure of DNA.

1.1.2 A gene codes for the production of …

A a chromosome.
B an allele.
C DNA.
D a protein.

1.1.3 Which ONE of the following is a characteristic of stem cells?

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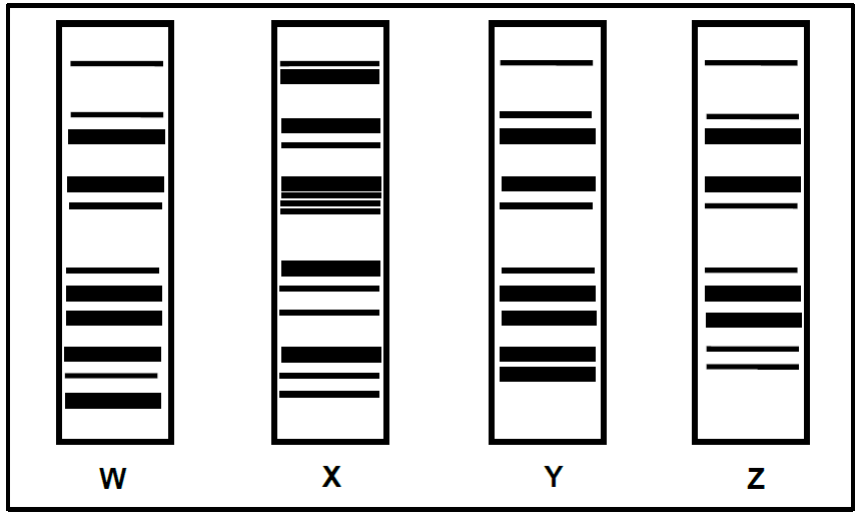
SECTION A – Multiple Choice

1.1.6 The DNA profiles of four individuals is given below. Which individuals are possible members of the same family?



A X and Z only

B X, Y and Z only

C W, Y and Z only

D W, X and Y only

Grade 12 Life Sciences Part 2 p. 11 (2024 ed.)

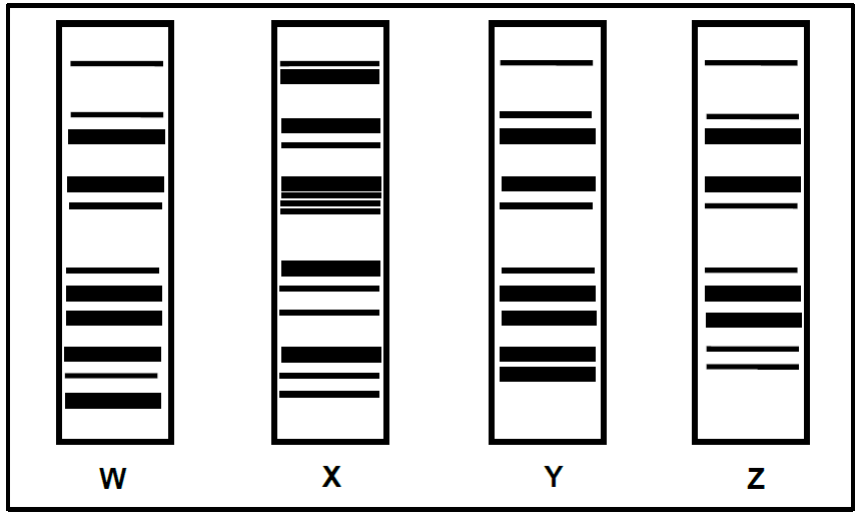
1.1.7 When two plants heterozygous for a characteristic are crossed, the expected ratio is:

	Dominant phenotype	:	Recessive phenotype
A	3	:	1
B	1	:	3
C	1	:	2
D	1	:	1

Grade 12 Life Sciences Part 2 p. 50 (2024 ed.)

SECTION A – Multiple Choice

1.1.6 The DNA profiles of four individuals is given below. Which individuals are possible members of the same family?



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B X, Y and Z only

C W, Y and Z only

D W, X and Y only

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A	3	:	1
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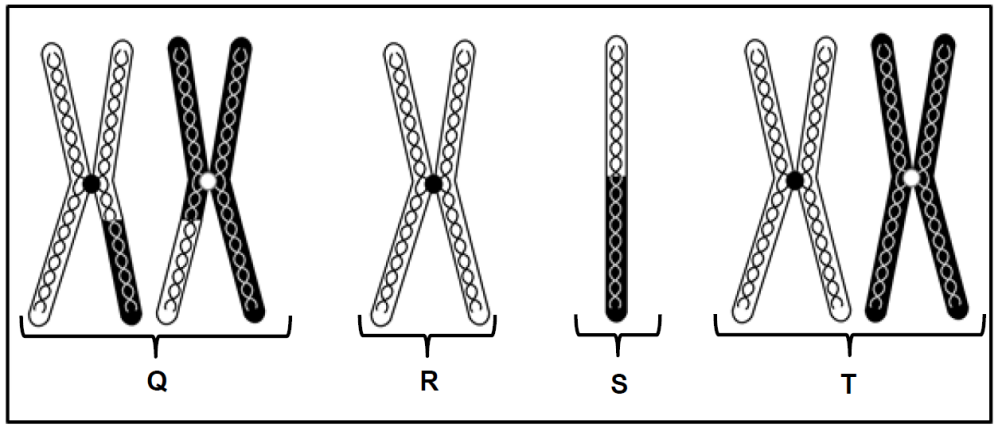
SECTION A – Tricky Multiple Choice

1.1.8 The diagram below represents the structure of chromosomes at different stages of meiotic cell division. Which ONE of the following chromosomes would be found in a cell during late Anaphase II?



A **Q**

B **R**

C **S**

D **T**

Grade 12 Life Sciences Part 2 p. 22 (2024 ed.)

1.1.9 The scientist who discovered Little Foot is …

A Lee Berger.

B Raymond Dart.

C Ron Clarke.

D Robert Broom.

Grade 12 Life Sciences Part 2 p. 183 (2024 ed.)

SECTION A – Tricky Multiple Choice

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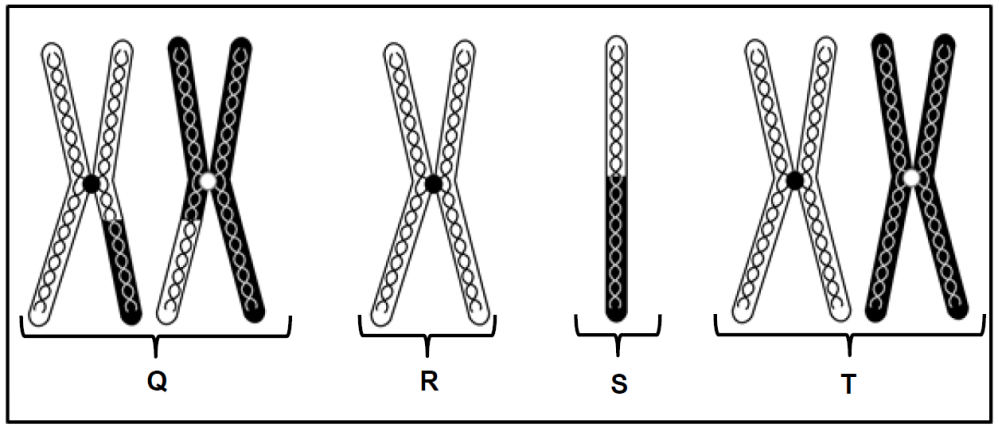


A **Q**

B **R**

C **S**

D **T**

1.1.9 The scientist who discovered Little Foot is …

A Lee Berger.

B Raymond Dart.

C Ron Clarke.

D Robert Broom.

A number of candidates did not know the South African scientists and the fossils they discovered.

SECTION A – Terminology

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.2.1 to 1.2.10) in the ANSWER BOOK.

1.2.1 The position of a gene on a chromosome.

1.2.2 The type of evolution characterised by long periods of little or no change followed by short periods of rapid change.

1.2.3 The natural shape of a DNA molecule.

1.2.4 The type of bond found between two amino acids.

1.2.5 The type of vision shared in primates that allows for depth perception.

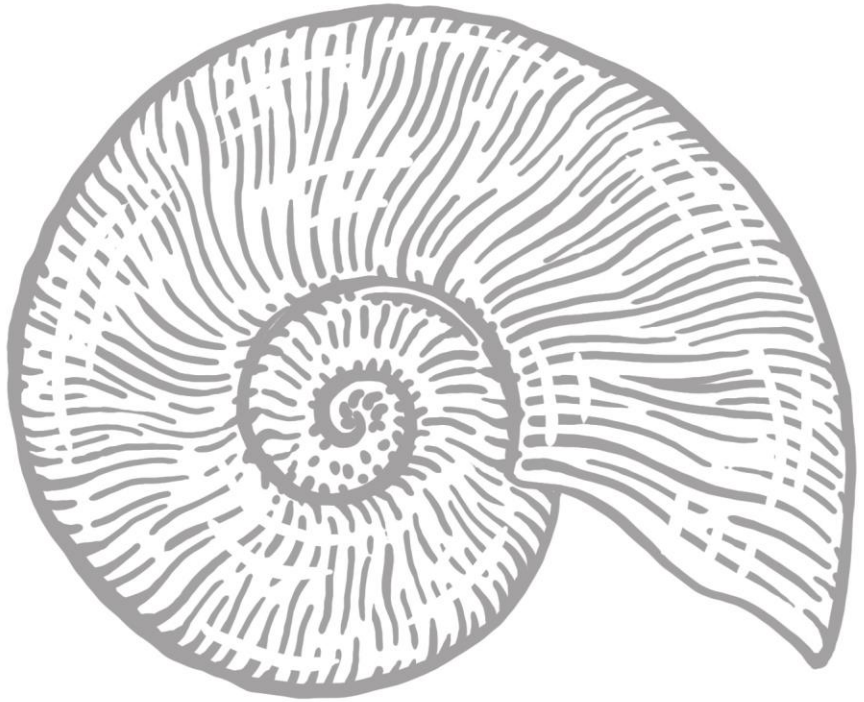
1.2.6 The type of dominance which results in an intermediate phenotype in the heterozygous condition.

1.2.7 The fluid of the nucleus where free nucleotides are found.

1.2.8 A tangled mass of chromosomes located within the nucleus.

1.2.9 The division of the cytoplasm after a nuclear division.

1.2.10 The name for the X and Y sex chromosomes in humans.



SECTION A – Terminology

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.2.1 to 1.2.10) in the ANSWER BOOK.

		Memorandum	Common misconceptions & Errors
1.2.1	The position of a gene on a chromosome.	locus✓	
1.2.2	The type of evolution characterised by long periods of little or no change followed by short periods of rapid change.	punctuated equilibrium✓	
1.2.3	The natural shape of a DNA molecule.	double helix✓	Provided *double stranded helix* ✗
1.2.4	The type of bond found between two amino acids.	peptide✓ bond	Provided *polypeptide* ✗ *bond* / *peptile* ✗ *bond*
1.2.5	The type of vision shared in primates that allows for depth perception.	stereoscopic✓/binocular vision	
1.2.6	The type of dominance which results in an intermediate phenotype in the heterozygous condition.	incomplete✓ dominance	Confused with *co-dominance*✗ / *complete* ✗ *dominance*
1.2.7	The fluid of the nucleus where free nucleotides are found.	nucleoplasm✓	
1.2.8	A tangled mass of chromosomes located within the nucleus.	chromatin network✓	Provided only *chromatin*✗
1.2.9	The division of the cytoplasm after a nuclear division.	cytokinesis✓	
1.2.10	The name for the X and Y sex chromosomes in humans.	gonosomes✓	

SECTION A – Item/statement columns

Indicate whether each of the descriptions in COLUMN I apply to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question number (1.3.1 to 1.3.3) in the ANSWER BOOK.

	COLUMN I	COLUMN II
1.3.1	A genetic disorder caused by a chromosomal mutation	A: Haemophilia B: Colour-blindness
1.3.2	The importance of meiosis	A: Formation of gametes B: Halving of the chromosome number
1.3.3	The organelle where DNA is found in plants	A: Mitochondria B: Chloroplast

Grade 12 Life Sciences Part 2 p. 61 & 63 (2024 ed.)

Grade 12 Life Sciences Part 2 p. 33 (2024 ed.)

Grade 12 Life Sciences Part 2 p. 3 (2024 ed.)

SECTION A – Item/statement columns

Indicate whether each of the descriptions in COLUMN I apply to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question number (1.3.1 to 1.3.3) in the ANSWER BOOK.

	COLUMN I	COLUMN II
1.3.1	A genetic disorder caused by a chromosomal mutation	A: Haemophilia B: Colour-blindness
1.3.2	The importance of meiosis	A: Formation of gametes B: Halving of the chromosome number
1.3.3	The organelle where DNA is found in plants	A: Mitochondria B: Chloroplast

Memorandum

None ✓✓

Both A and B ✓✓

Both A and B ✓✓

Common misconceptions & Errors

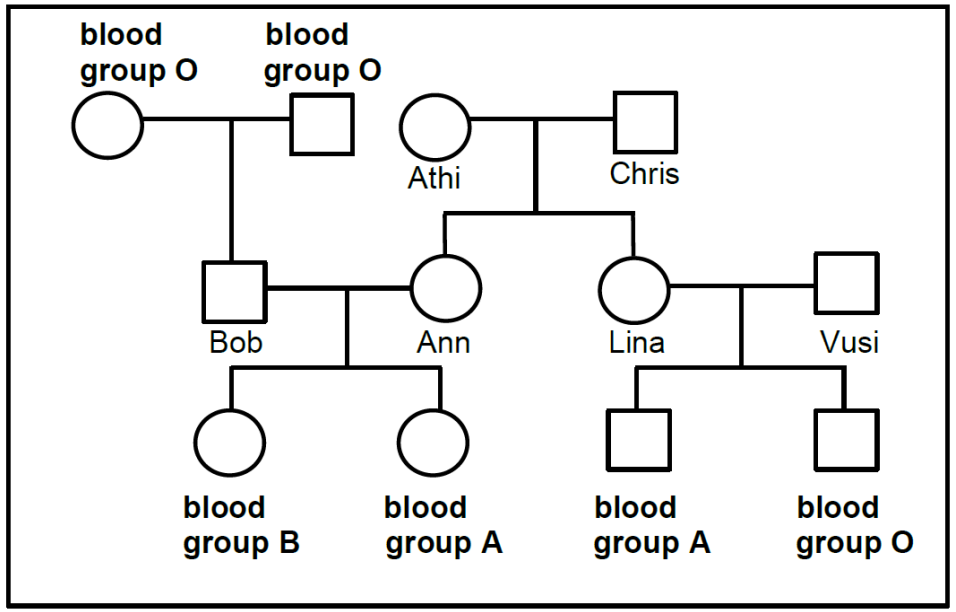
Candidates did not follow instructions and lost marks for writing A/B✗ instead of the required A and B✓✓

1.3.1 Candidates did not know which genetic disorders are caused by gene or chromosomal mutations.

1.3.3 Candidates did not know that plants contain mitochondria.

SECTION A – Pedigree diagram

1.4 The diagram shows the inheritance of blood groups in a family.



1.4.1 Name the type of diagram shown.

1.4.2 Give the number of alleles that control blood groups.

1.4.3 How many generations are represented in the diagram?

1.4.4 Lina's genotype is I^Ai. State ALL the possible genotypes of Vusi.

1.4.5 Give the genotype of Bob.

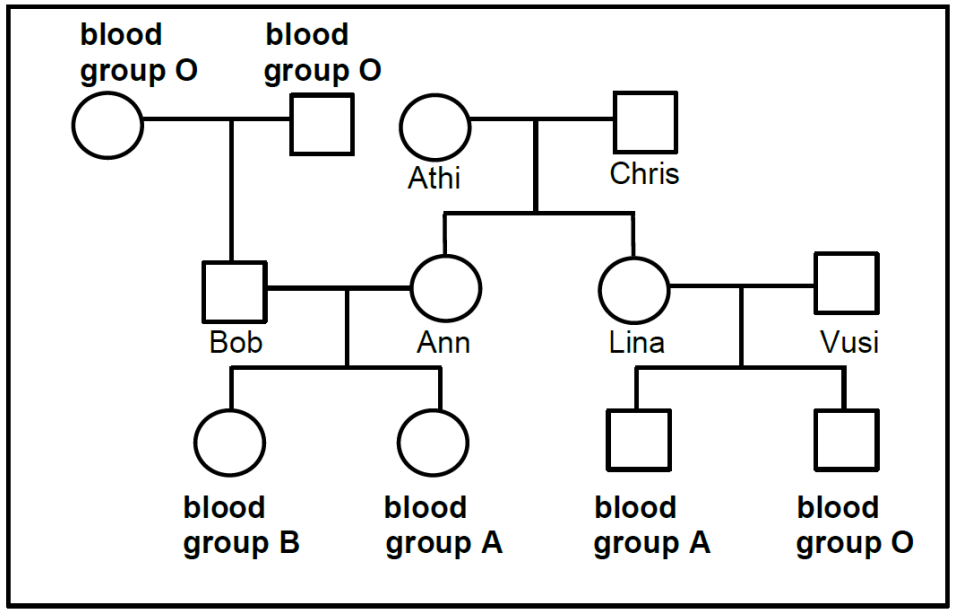
1.4.6 Give the name of the individual who displays co-dominance.

Common misconceptions & Errors

Grade 12 Life Sciences Part 2 p. 54 – 55 & 64 (2024 ed.)

SECTION A – Pedigree diagram

1.4 The diagram shows the inheritance of blood groups in a family.



1.4.1 Name the type of diagram shown.

pedigree✓ diagram (1)

1.4.2 Give the number of alleles that control blood groups.

3✓/three (1)

1.4.3 How many generations are represented in the diagram?

3✓/three (1)

1.4.4 Lina's genotype is I^Ai. State ALL the possible genotypes of Vusi.

[I^Ai, I^Bi, ii]✓✓ (2)

1.4.5 Give the genotype of Bob.

ii✓ (1)

1.4.6 Give the name of the individual who displays co-dominance.

Ann✓✓ (2)

Common misconceptions & Errors

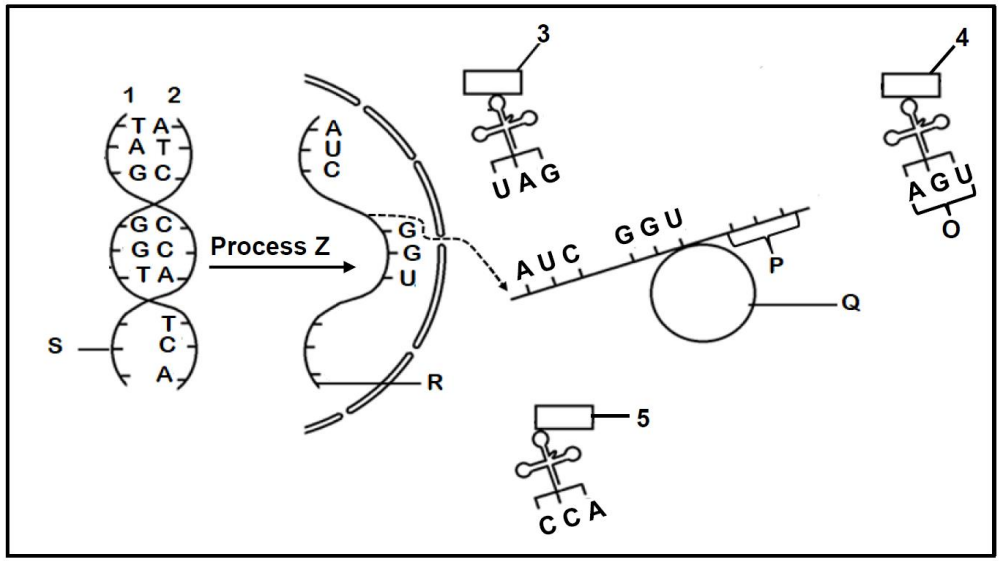
1.4.4 Candidates did not provide ALL the possible genotypes as indicated in the question. They seem to have been confused by the mark allocation, i.e. thinking that 2 marks means providing only 2 genotypes.

The 2 marks were only awarded if ALL THREE possible genotypes were provided.

1.4.5 Candidates incorrectly wrote the scientific notation of blood group O's genotype as I^oI^o or I^iI^i.

SECTION A – Protein Synthesis

1.5 The diagram is a schematic representation of protein synthesis.



1.5.1 Identify:

(a) process **Z**

(b) molecule **R**

(c) organelle **Q**

1.5.2 Give the collective name of nitrogenous bases **O**.

1.5.3 Determine the sequence of the nitrogenous bases at area **S**.

Common misconceptions & Errors

SECTION A – Protein Synthesis

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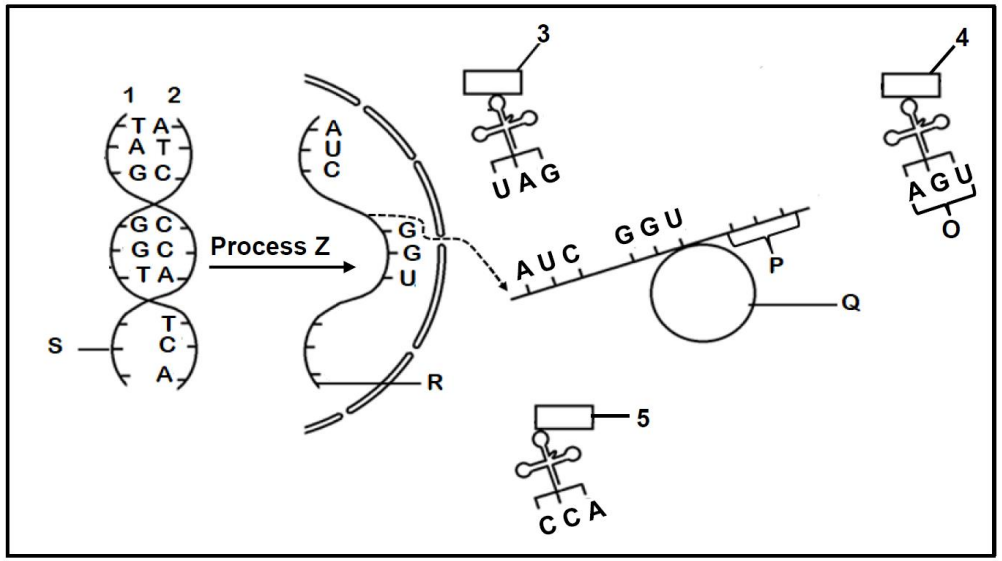


1.5.1 Identify:

(a) process **Z**

transcription✓ (1)

(b) molecule **R**

mRNA✓/messenger RNA (1)

(c) organelle **Q**

ribosome✓ (1)

1.5.2 Give the collective name of nitrogenous bases **O**. anticodon✓ (1)

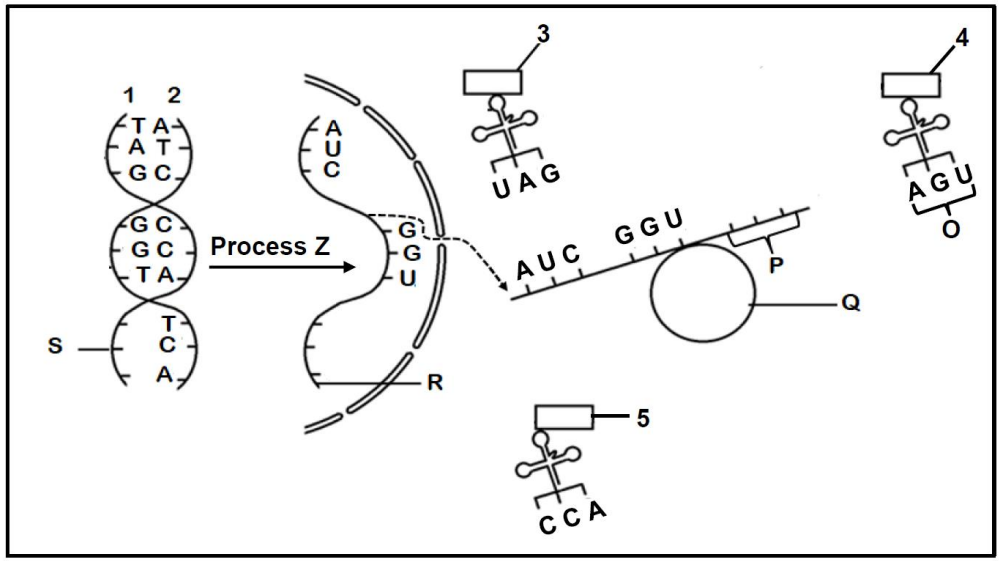
1.5.3 Determine the sequence of the nitrogenous bases at area **S**. AGT✓ (1)

Common misconceptions & Errors

1.5.3 Candidates showed their thought process, which may have disadvantaged them as they only needed to show the correct answer – be sure to indicate the final answer clearly!

SECTION A – Protein Synthesis

1.5 The diagram is a schematic representation of protein synthesis.



1.5.4 Which strand (**1** or **2**) was used as a template for the formation of molecule **R**?

1.5.5 Which amino acid (**3**, **4** or **5**) will be brought to area **P**?

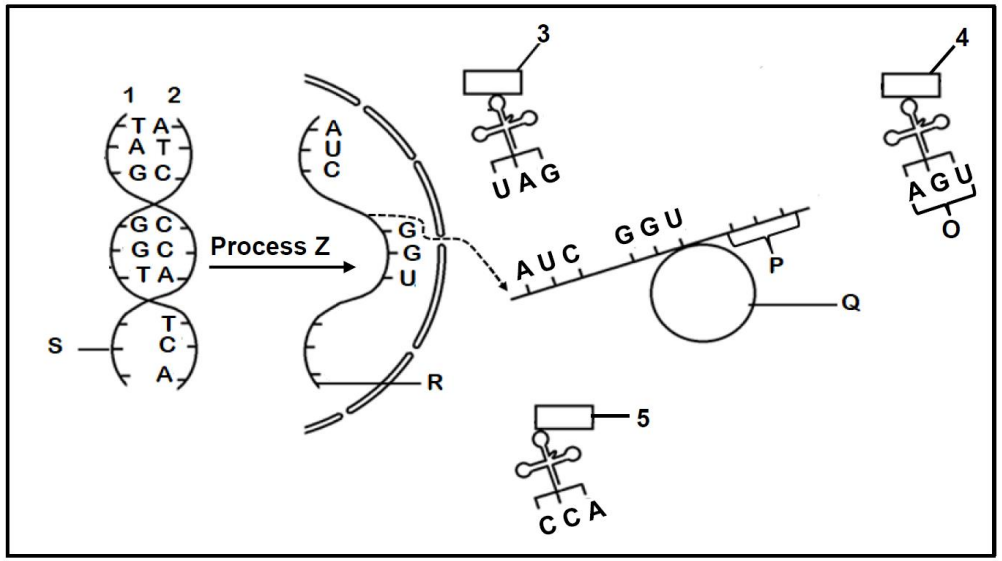
1.5.6 Name the type of sugar that forms part of the structure of molecule **R**.

Common misconceptions & Errors

Grade 12 Life Sciences Part 2 p. 9 & 11

SECTION A – Protein Synthesis

1.5 The diagram is a schematic representation of protein synthesis.



1.5.4 Which strand (**1** or **2**) was used as a template for the formation of molecule **R**?

1✓ (1)

1.5.5 Which amino acid (**3**, **4** or **5**) will be brought to area **P**?

4✓ (1)

1.5.6 Name the type of sugar that forms part of the structure of molecule **R**.

ribose✓ (1)

Common misconceptions & Errors

1.5.6 Candidates incorrectly wrote *pentose** for the specific type of sugar in mRNA.

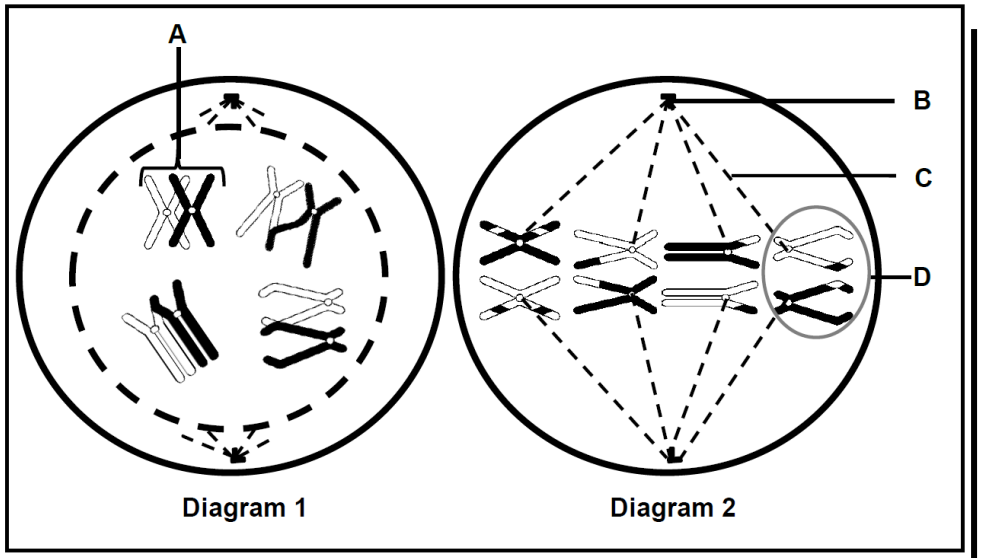
**Pentose is the collective name for all sugars making up the nucleic acids – not required by CAPS.*

SECTION A – Suggestions for improvement

- ☑ Ensure that learners are provided with the historical information relating to the discovery of DNA.
  - *Wilkins and Franklin – used X-ray diffraction to discover the double helix nature of DNA*
  - *Watson and Crick – discovered base pairing nature of DNA*
  - *Watson, Crick, Wilkins and Franklin – credited with discovery of the structure of DNA*
  - *Watson, Crick and Wilkins received Nobel Prize (Franklin had passed on)*
- ☑ Learners should be knowledgeable about South African scientists who discovered fossils:
  - *Broom – Mr Ples (A. africanus)*
  - *Dart – Taung child (A. africanus)*
  - *Clarke – Little foot (A. spp.)*
  - *Berger – Karabo (A. sediba)*
- ☑ Only supply ONE answer to multiple choice, terminology and items and statement questions
- ☑ Biological terminology can only be mastered through practice after each section is taught.

SECTION B – Meiosis

2.1 The diagrams represent two stages of meiotic cell division.



2.1.1 Name structure:

(a) **B**

(b) **C**

2.1.2 Identify the phase represented in Diagram **1**.

2.1.3 Give THREE reasons for your answer to QUESTION 2.1.2.

Common misconceptions & Errors

SECTION B – Meiosis

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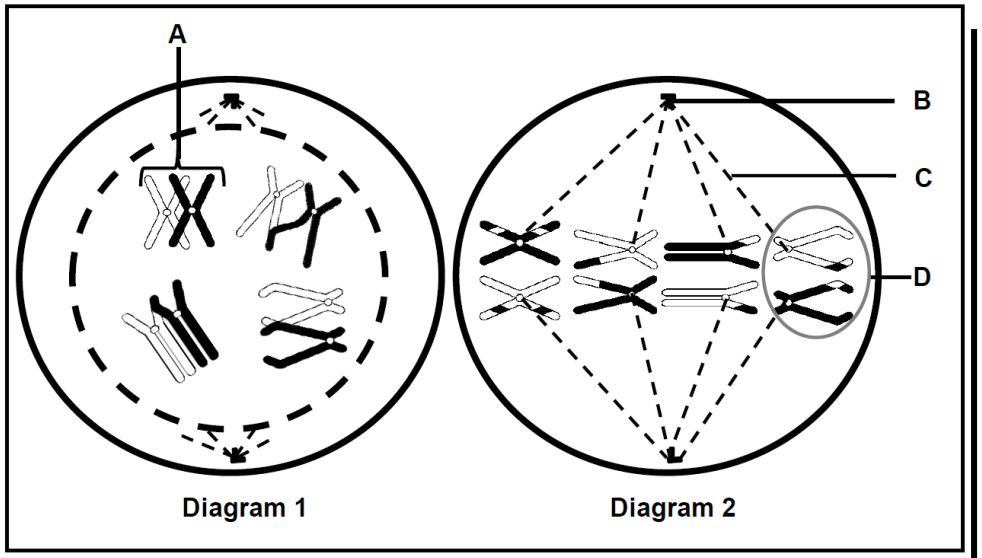


2.1.1 Name structure:

(a) **B**

centriole✓/ centrosome (1)

(b) **C**

spindle fibre✓ (1)

2.1.2 Identify the phase represented in Diagram **1**. Prophase I✓ (1)

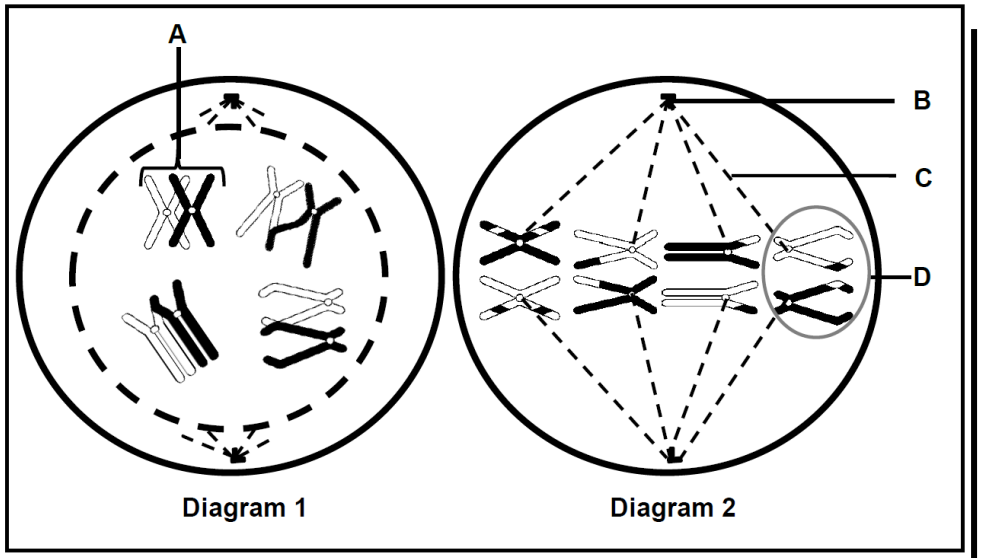
2.1.3 Give THREE reasons for your answer to QUESTION 2.1.2.

- pairing of homologous chromosomes is visible✓/ bivalents are visible
- development of spindle fibres✓
- crossing over is taking place✓
- centriole/centrosome moved to opposite poles✓
- disintegration of nuclear membrane✓ (first 3)

Common misconceptions & Errors

SECTION B – Meiosis

2.1 The diagrams represent two stages of meiotic cell division.



2.1.4 Describe the process taking place at **A**.

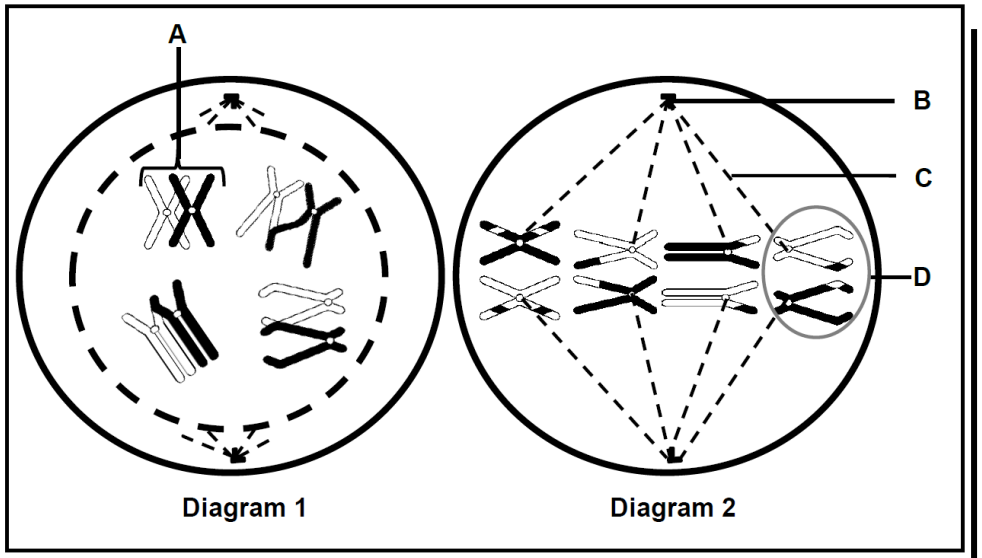
2.1.5 (a) Identify the phase represented in Diagram **2**.

(b) Describe the difference in the events that take place in the phase mentioned in (a) and the same phase during mitosis.

Common misconceptions & Errors

SECTION B – Meiosis

2.1 The diagrams represent two stages of meiotic cell division.



2.1.4 Describe the process taking place at **A**.

- part of the homologous chromosomes overlap✓ and
- DNA/genetic material is exchanged✓
- at points called chiasmata✓/ chiasma (3)

2.1.5 (a) Identify the phase represented in Diagram **2**.

Metaphase I✓ (1)

(b) Describe the difference in the events that take place in the phase mentioned in (a) and the same phase during mitosis.

- In Metaphase I / Meiosis I chromosomes are arranged in pairs at the equator✓ / double row
- In Mitosis the chromosomes are arranged singly at the equator✓ / single row (2)

Common misconceptions & Errors

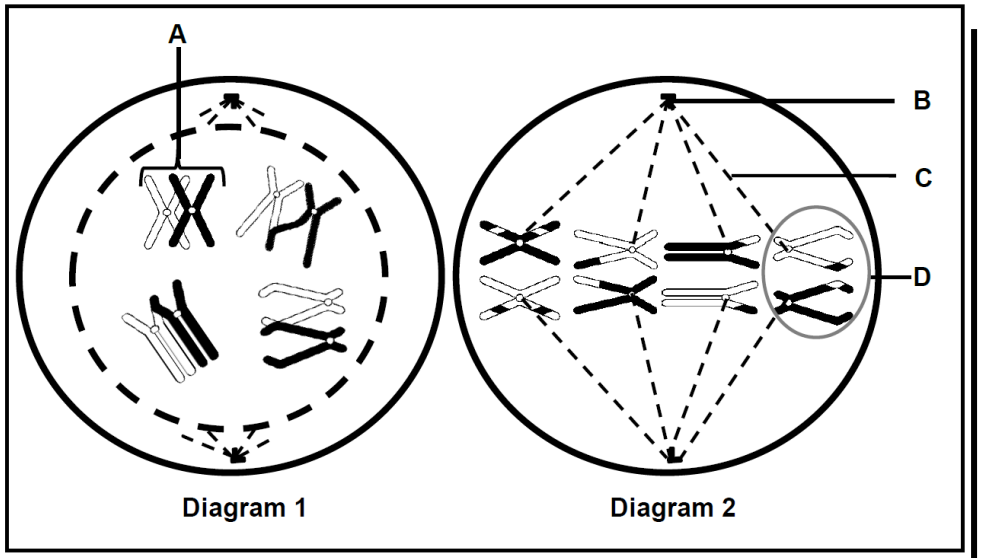
2.1.5 (b) Candidates could not state how *metaphase I* is different from *metaphase of mitosis* as most candidates gave events taking place in *metaphase of mitosis*.

A number of candidates did not know the events taking place in mitosis which had been taught in Grade 10 and are prescribed in the Grade 12 curriculum.

Many candidates incorrectly referred to the *bivalents* lying at the equator in metaphase I.

SECTION B – Meiosis

2.1 The diagrams represent two stages of meiotic cell division.

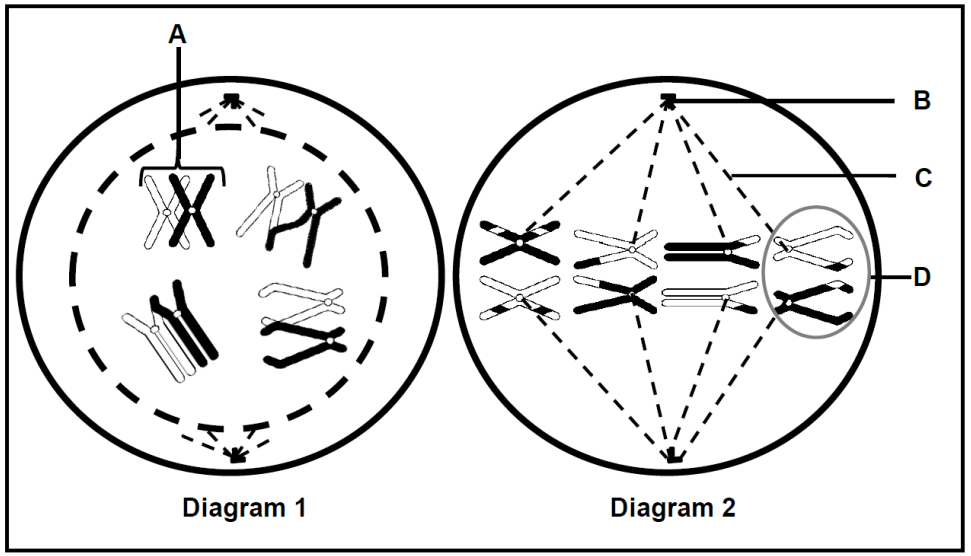


2.1.6 Describe the results at the end of meiosis if the chromosomes at **D** failed to separate.

Common misconceptions & Errors

SECTION B – Meiosis

2.1 The diagrams represent two stages of meiotic cell division.



2.1.6 Describe the results at the end of meiosis if the chromosomes at **D** failed to separate.

- four (daughter) cells will be formed✓ of which
- two will each have five chromosomes✓ and
- the other two will each have three chromosomes✓ (3)

Common misconceptions & Errors

2.1.6 Candidates could not apply the knowledge of abnormal meiosis when given a new scenario or did not understand what the question required.

Most candidates explained how non-disjunction led to Down syndrome as in the memos of past papers.

Remember to be specific and answer the question at hand.

Let's understand this

SECTION B – DNA Replication

2.2 Describe the process of DNA replication.

Common misconceptions & Errors

SECTION B – DNA Replication

2.2 Describe the process of DNA replication.

- the (DNA) double helix unwinds✓ and
- unzips✓ / hydrogen bonds break
- to form two separate strands✓
- both (DNA) strands serve as templates✓
- to build a complementary (DNA) strand✓ / A pairs with T and C pairs with G
- using free (DNA) nucleotides✓ from the nucleoplasm
- this results in two identical (DNA) molecules✓ (any 6)

Common misconceptions & Errors

Notable errors by some candidates:

- not describing the *double helix* nature of the *DNA that unwinds*
- not mentioning the step, *forms two separate strands* after unzipping
- stating that *two DNA strands* are formed instead of *two identical DNA molecules* are formed.

SECTION B – DNA Mutation

2.3 Read the information.

> A gene, VKORC1, codes for a blood-clotting factor in humans. This gene is made up of 163 amino acids.
>
> A mutation occurred that affected amino acid 128 and 139, the sequence CTG changed to CAG and the TAT became TCT. This mutation has been transmitted as an autosomal dominant characteristic through the generations.
>
> The mutation has resulted in resistance to Warfarin drugs in humans. Warfarin is used in the treatment of thrombosis. Thrombosis results in the formation of a blood clot in the artery. Warfarin causes the thinning of blood to break down the blood clot.

2.3.1 Give ONE piece of evidence from the information that shows that the mutation for this gene occurred in the DNA molecule.

2.3.2 How many nitrogenous bases code for the VKORC1 gene?

2.3.3 Describe what is meant by an *autosomal dominant allele*.

Common misconceptions & Errors

SECTION B – DNA Mutation

2.3 Read the information.

> A gene, VKORC1, codes for a blood-clotting factor in humans. This gene is made up of 163 amino acids.
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> The mutation has resulted in resistance to Warfarin drugs in humans. Warfarin is used in the treatment of thrombosis. Thrombosis results in the formation of a blood clot in the artery. Warfarin causes the thinning of blood to break down the blood clot.

2.3.1 Give ONE piece of evidence from the information that shows that the mutation for this gene occurred in the DNA molecule.

The presence of T✓/thymine in the original sequence (1)

2.3.2 How many nitrogenous bases code for the VKORC1 gene?

489✓✓ (2)

2.3.3 Describe what is meant by an *autosomal dominant allele*.

- a form of a gene✓
- that is carried on chromosome 1 to 22✓ and
- is always expressed in the phenotype✓ of an individual
- in the heterozygous✓ condition (any 3)

Common misconceptions & Errors

2.3.1 Candidates quoted the sentence directly from the text and could not answer why it was a DNA molecule.

2.3.3 Candidates did not describe all the terms (*autosome, dominant* and *allele*) and mainly focused on the *dominant* part alone.

Some candidates confused *somatic cell* and *autosome* or incorrectly stated that *autosomes were chromosomes* for body characteristics.

Let's revise this

SECTION B – DNA Mutation

2.3

2.3.4 The table shows the amino acids and their corresponding codons.

CODONS	AMINO ACID
GAC	Leu
UCU	Ser
AUA	Try
GUC	Gln
AGA	Arg
ACA	Trp
CAG	Gln
UAU	Phe

Explain:

(a) How the mutation on the VKORC1 gene resulted in resistance to Warfarin in humans.

(b) The effect of this mutation on humans with thrombosis.

Common misconceptions & Errors

SECTION B – DNA Mutation

2.3 2.3.4 The table shows the amino acids and their corresponding codons.

CODONS	AMINO ACID
GAC	Leu
UCU	Ser
AUA	Try
GUC	Gln
AGA	Arg
ACA	Trp
CAG	Gln
UAU	Phe

Explain:

(a) How the mutation on the VKORC1 gene resulted in resistance to Warfarin in humans.

- the codon changed from GAC to GUC✓
- resulting in amino acid Leu being replaced by Gln✓
- the other codon changed from AUA to AGA✓
- resulting in amino acid Try being replaced by Arg✓
- this changed the sequence of amino acids✓ and
- a different protein was formed✓ (any 5)

(b) The effect of this mutation on humans with thrombosis.

- harmful✓ effect
- the blood clot is not broken down✓
- leading to blockage of arteries✓ / oxygen and nutrients are not transported to cells (3)

Common misconceptions & Errors

2.3.4(a) Candidates could not apply the knowledge on gene mutation in a new scenario; most gave generic answers without referring to the specific codons and amino acids that changed. Many candidates did not refer to a *change in the sequence of amino acids*. Most candidates confused this question as asking for natural selection because of the concept *resistance to warfarin*.

2.3.4(b) Candidates did not understand the effects of mutations on individuals as harmful/harmless/neutral/beneficial and could not explain how this would affect the humans if they had thrombosis. Many stated that a person would die, which is a secondary effect. Some stated that the person would have a blood clot in the artery (thrombosis) which was part of the question.

SECTION B – Dihybrid Cross

2.4 Polydactyly is a condition that leads to extra fingers or toes. It is caused by a dominant allele.

A man who is heterozygous for polydactyly has a wife who is not polydactyl.

Using the letters **R** and **r**, do a genetic cross to show the percentage chance that their children will have polydactyly.

Common misconceptions & Errors

SECTION B – Dihybrid Cross

2.4 Polydactyly is a condition that leads to extra fingers or toes. It is caused by a dominant allele.

A man who is heterozygous for polydactyly has a wife who is not polydactyl.

Using the letters **R** and **r**, do a genetic cross to show the percentage chance that their children will have polydactyly.

P_1 Phenotype with polydactyly x without polydactyly ✓

Genotype Rr x rr ✓

Meiosis

Gametes R ; r x r; r ✓

Fertilisation

✓ Correct gametes

Gametes	R	r
r	Rr	rr
r	Rr	rr

✓ correct genotypes

F_1 Phenotype 2 polydactyly : 2 without polydactyly ✓

50% ✓* chance of polydactyl child

*1 compulsory mark + any 5 (6)

Common misconceptions & Errors

Notable errors by some candidates:

- describing the *phenotypes* of the parents and offspring *as heterozygous for polydactyly* (this is a description of the genotype!)
- writing P_1 and F_1, *meiosis* and *fertilisation* in the incorrect places
- wrote *fusion* instead of *fertilisation*
- gave a *ratio* instead of a *percentage of offspring* that would be polydactyl (as required by the question)
- incorrectly approached the question as a sex-linked disorder

SECTION B – Dihybrid Cross

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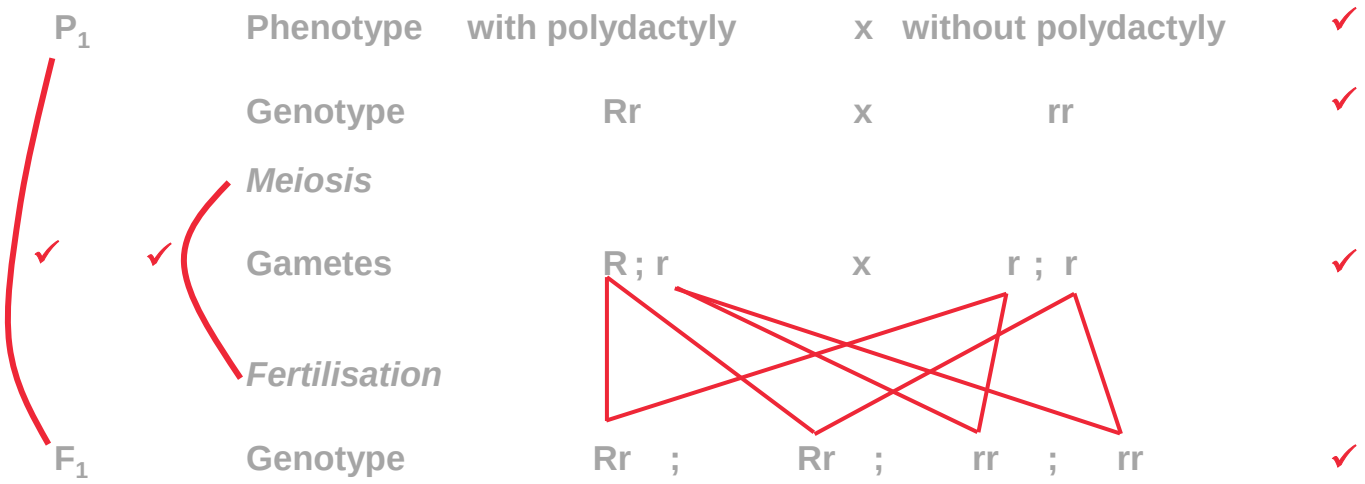
A man who is heterozygous for polydactyly has a wife who is not polydactyl.

Using the letters **R** and **r**, do a genetic cross to show the percentage chance that their children will have polydactyly.



*1 compulsory mark + any 5 (6)

Common misconceptions & Errors

Notable errors by some candidates:

- describing the *phenotypes* of the parents and offspring *as heterozygous for polydactyly* (this is a description of the genotype!)
- writing P_1 and F_1, *meiosis* and *fertilisation* in the incorrect places
- wrote *fusion* instead of *fertilisation*
- gave a *ratio* instead of a *percentage of offspring* that would be polydactyl (as required by the question)
- incorrectly approached the question as a sex-linked disorder

SECTION B – Dihybrid Cross

2.5 In summer squash plants, white fruit colour **(B)** is dominant over yellow fruit colour **(b)**, and round fruit **(D)** is dominant over oval fruit **(d)**.

A summer squash plant that is homozygous for white and round fruit is crossed with a plant that is homozygous for yellow and oval fruit.

2.5.1 State the:

(a) Genotypes of the P_1-parents

(b) Phenotypes of the F_1-generation

2.5.2 Two plants that are heterozygous for both characteristics were crossed.

(a) Give ALL the possible genotypes in the **gametes** that will be formed.

(a) How many plants in the next generation are likely to have yellow and oval fruit?

2.5.3 Give the possible genotypes of both parents that must be crossed if a farmer wants summer squash that are white with oval fruit only.

Common misconceptions & Errors

SECTION B – Dihybrid Cross

2.5 In summer squash plants, white fruit colour **(B)** is dominant over yellow fruit colour **(b)**, and round fruit **(D)** is dominant over oval fruit **(d)**.

A summer squash plant that is homozygous for white and round fruit is crossed with a plant that is homozygous for yellow and oval fruit.

2.5.1 State the:

(a) Genotypes of the P_1-parents BBDD✓ and bbdd✓ (2)

(b) Phenotypes of the F_1-generation white, round fruit✓✓ (2)

2.5.2 Two plants that are heterozygous for both characteristics were crossed.

(a) Give ALL the possible genotypes in the **gametes** that will be formed.

[BD, bD, Bd, bd]✓✓ (2)

(a) How many plants in the next generation are likely to have yellow and oval fruit?

one✓/1 (1)

2.5.3 Give the possible genotypes of both parents that must be crossed if a farmer wants summer squash that are white with oval fruit only.

BBdd and BBdd✓✓ OR BBdd and Bbdd✓✓ OR BBdd and bbdd✓✓ (2)

Common misconceptions & Errors

2.5.1(a) Candidates wrote the genotype of one parent only while the question asked for the genotypes of the parents.

2.5.1(b) Incorrectly gave the genotype, i.e. *heterozygous* round and white, **OR** only one phenotype **OR** listed all the phenotypes involved in the cross.

2.5.2 Candidates confused the *genotype* in the *gametes* as the *genotypes* in *the somatic cell* **OR** did not provide ALL the possible gametes for two marks.

2.5.3 Candidates wrote the genotype of one parent only while the question asked for the genotypes of the parents.

Wrote BB x DD or BB DD or BB,DD which does not represent the genotype of a parent.

SECTION B QUESTION 2 – Suggestions for improvement

- ☑ Know the differences between Meiosis I and Meiosis II. **Note that Meiosis II is similar to Mitosis.*

Let's revise this

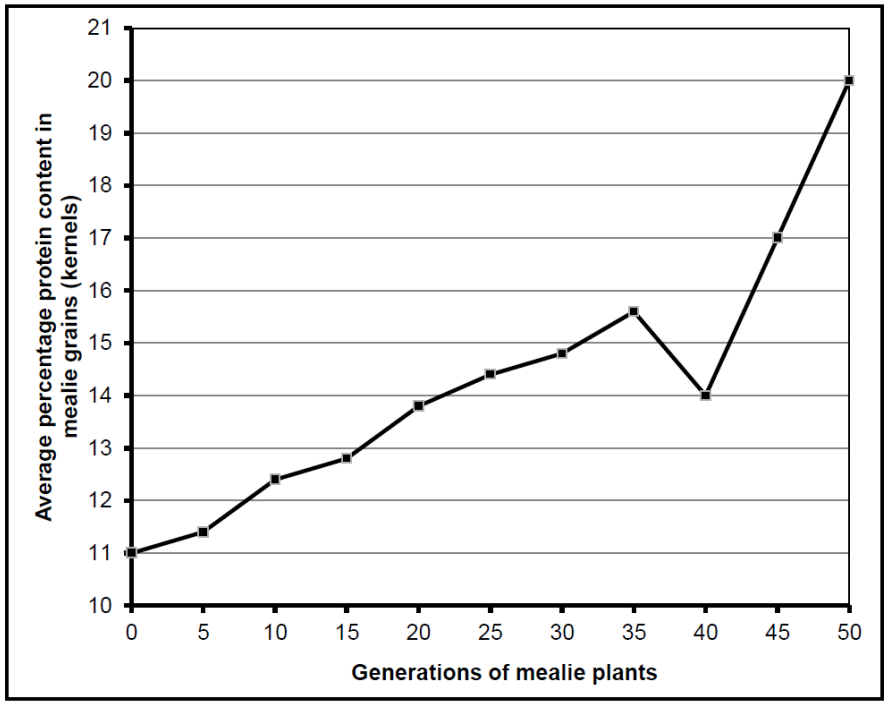
- ☑ Mutations have three effects or consequences on an individual or population:
  - *Harmless/neutral – have no effect on the individual / no characteristic is affected*
  - *Harmful – can results in sickness/disorder which may/may not lead to death*
  - *Beneficial – mutated characteristic may allow organisms to survive if the environment changes*
- ☑ A gene mutation would occur either during replication or transcription. Learners must be taught how to identify this and apply it to a given context:
  - *A change in the sequence of nitrogenous bases on mRNA*
  - *This caused an amino acid to be replaced*
  - *Resulting in a change in the sequence of amino acids*
  - *Forming a different / the same protein*

Let's understand this

- ☑ Learn the sequence of steps describing DNA replication as stated in the Exam Guidelines.
  - *Be able to apply this generic process to the source material provided*
  - *Tailor answers to the context of the question*

SECTION B – Artificial Selection & Genetic Engineering

3.1 The graph shows the results of artificial selection for protein content in mealie plants over 50 generations.



3.1.1 Describe how this farmer did artificial selection of the mealie plant.

3.1.2 What was the average percentage of the protein content in the mealie grains (kernels) at the 15th generation?

Common misconceptions & Errors

SECTION B – Artificial Selection & Genetic Engineering

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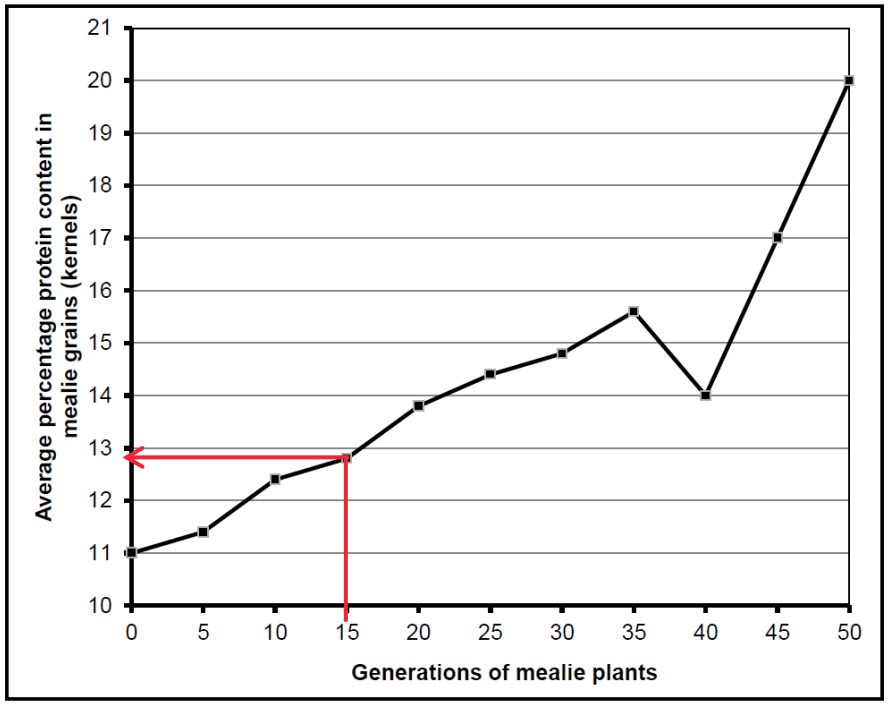

3.1.1 Describe how this farmer did artificial selection of the mealie plant.

- the farmer inbred✓
- mealie plants with a high protein content✓
- over 50 / many generations✓ (3)

3.1.2 What was the average percentage of the protein content in the mealie grains (kernels) at the 15th generation?

12,8✓% (accept 12,7 – 12,9%) (1)

Common misconceptions & Errors

Question 3.1 scored the lowest marks in the paper.

3.1.1 Candidates lacked the ability to apply the process of artificial selection to a given scenario. They gave generic responses and many confused *artificial selection* with *genetic engineering*.

SECTION B – Artificial Selection & Genetic Engineering

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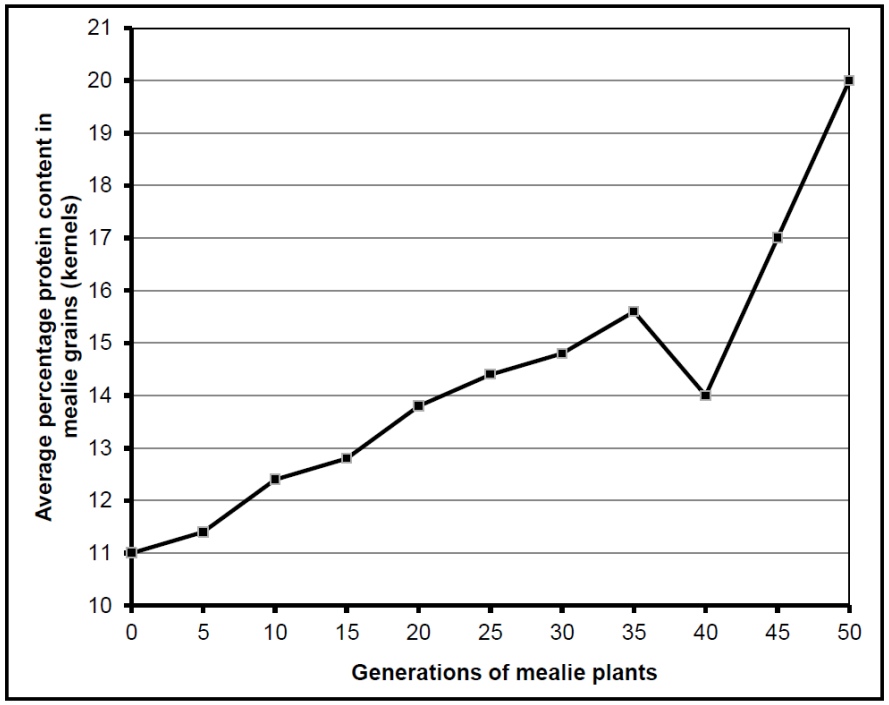


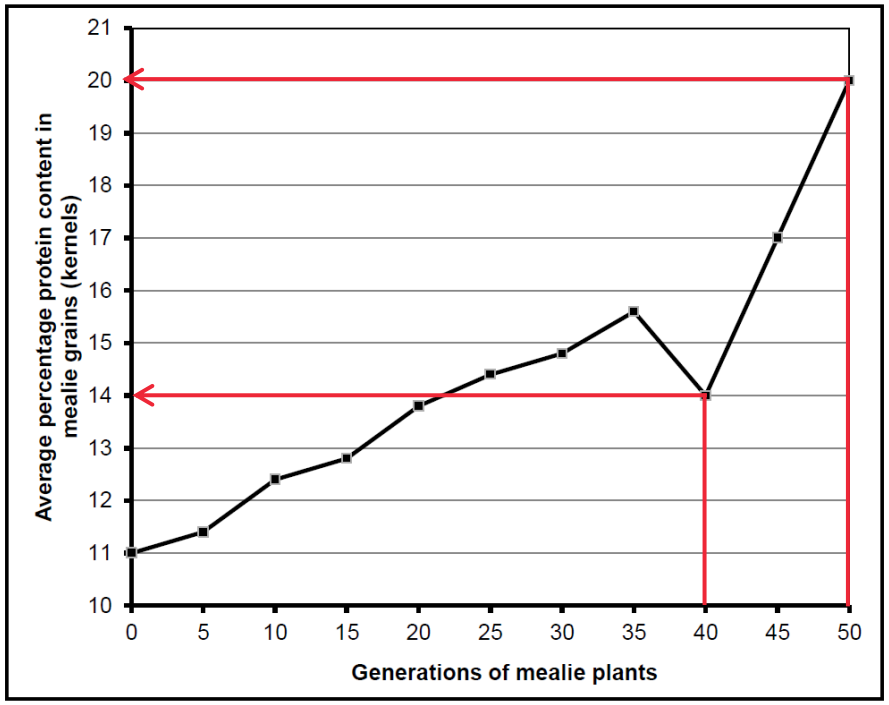
3.1.3 By how many times did the average percentage of the protein content in the mealie grains (kernels) increase between the 40th and 50th generation? Show ALL working.

3.1.4 Describe ONE way in which the process of artificial selection is different from genetic engineering.

Common misconceptions & Errors

SECTION B – Artificial Selection & Genetic Engineering

3.1 The graph shows the results of artificial selection for protein content in mealie plants over 50 generations.



3.1.3 By how many times did the average percentage of the protein content in the mealie grains (kernels) increase between the 40th and 50th generation? Show ALL working.

$\frac{20}{14}$ ✓ = 1,43✓ times (2)

3.1.4 Describe ONE way in which the process of artificial selection is different from genetic engineering.

Artificial selection: organisms with a desired characteristic are interbred✓

Genetic engineering: genes coding for the desired characteristic are inserted into an organism✓ (2)

Common misconceptions & Errors

3.1.3 Candidates did not know how to do this calculation. They incorrectly calculated the percentage increase or the difference.

3.1.4 The majority of candidates could not differentiate between the processes of *artificial selection* and *genetic engineering*.

SECTION B – Natural Selection

3.2 Describe Darwin's theory of evolution by natural selection.

Common misconceptions & Errors

SECTION B – Natural Selection

3.2 Describe Darwin's theory of evolution by natural selection.

- there is variation amongst the offspring in a population✓
- some have favourable characteristics and some do not✓
- when there is a change in the environmental conditions✓ / competition
- organisms with a favourable characteristic survive✓
- whilst organisms with an unfavourable characteristic die✓
- the organisms that survive, reproduce✓
- and pass on the allele for the favourable characteristic to their offspring✓
- the next generation will therefore have a higher proportion of individuals with the favourable characteristic✓ (any 7)

Common misconceptions & Errors

Notable errors by some candidates:

- referred to variation within a species/ organisms (Remember: natural selection occurs in a *population*!)
- wrote *desirable characteristic* instead of *favourable characteristic*
- stated that organisms *that could not adapt died* instead of understanding that organisms either are or are not adapted from the start. Therefore, organisms *that were not adapted died.*
- indicated that these organisms *became extinct* instead of *died out*
- stated that organisms *produce* instead of *reproduce*
- indicated *ALL the individuals in the next generation* will have the favourable characteristic instead of understanding that *there will be a greater proportion of these individuals*

SECTION B – Scientific Investigation (Evolution)

3.3 An investigation was done to determine the relationship between the height of the head and bite force in lizards. The procedure was as follows:

- The scientists collected 120 lizards with similar characteristics that were around the same reproductive age in different habitats.
- Their body characteristics and DNA were analysed to determine if they belonged to the same species.
- 40 lizards belonged to species **A**, 36 to species **B** and 44 to species **C**.
- Each species was kept in its cage with environmental conditions similar to their habitats.
- The height of the head was measured for each lizard and averages calculated for each species.
- Using a Kistler force, the bite force of each lizard in each species was measured five times and the average calculated for each lizard and each species.

The results are shown in the table below.

Species	Height of the head (mm)	Bite force (N)
A	10,3	12,4
B	10,7	14,3
C	13,2	20,4

3.3.1 Identify the:

(a) independent variable

(b) dependent variable

Common misconceptions & Errors

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3.3.1 Identify the:

(a) independent variable height of the head✓ (1)

(b) dependent variable bite force✓ (1)

Common misconceptions & Errors

3.3.1 Candidates incorrectly identified variables.

Some wrote *the effect of* for an independent variable.

Some swopped the two types of variables around.

SECTION B – Scientific Investigation (Evolution)

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3.3.2 State TWO factors that were kept constant for this investigation.

Common misconceptions & Errors

SECTION B – Scientific Investigation (Evolution)

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3.3.2 State TWO factors that were kept constant for this investigation.

- similar characteristics✓
- (same) reproductive age✓
- (same) measuring tool for bite force✓ / Kistler force used to measure bite force
- each species kept in environmental conditions similar to their habitats✓
- lizards of the same species in each group✓ (first 2)

Common misconceptions & Errors

3.3.2 Candidates failed to write the factors as outlined in the procedure. They stated *same species of lizard* instead of *similar species of lizard* **OR** *were kept in the same environment* instead of *were kept in an environment similar to their habitats*.

Some gave generic responses, e.g. *same measuring tool.*

Wrote out the whole sentence in the procedure and did not identify the exact constant variable in the sentence.

SECTION B – Scientific Investigation (Evolution)

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3.3.3 Apart from the sample size, state ONE way in which the reliability of the results was ensured for this investigation.

3.3.4 The height of the head was different in each species of lizard. Name the type of variation displayed by this characteristic.

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Common misconceptions & Errors

SECTION B – Scientific Investigation (Evolution)

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3.3.3 Apart from the sample size, state ONE way in which the reliability of the results was ensured for this investigation.

five measurements of the bite force✓ were taken (1)

3.3.4 The height of the head was different in each species of lizard. Name the type of variation displayed by this characteristic.

continuous✓ variation (1)

Common misconceptions & Errors

3.3.3 Candidates wrote a generic response or incorrectly stated that 'the *investigation* was done 5 times' instead of 'the *measurements* were done 5 times'.

Some stated that calculating an average increased the reliability – but you can only calculate an average if you have taken more than one measurement (i.e. repeated the measurements).

SECTION B – Scientific Investigation (Evolution)

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3.3.5 Describe the relationship between the height of the head of the lizards and the bite force.

Common misconceptions & Errors

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3.3.5 Describe the relationship between the height of the head of the lizards and the bite force.

Lizards with an increased head height have a stronger bite force✓✓

OR

Lizards with a decreased head height have a weaker bite force✓✓ (2)

Common misconceptions & Errors

3.3.5 Candidates did not write the relationship between the two variables to show which variable influenced the other.

Some wrote terms like *directly proportional* ✗ - in Life Sciences they are required to be explicit in the nature of the relationship between the variables.

In some cases, the candidates did not include all aspects (height of the head, bite force).

SECTION B – Scientific Investigation (Evolution)

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3.3.6 Which species (**A**, **B** or **C**) would be expected to be feeding mainly on tough fibrous plants?

3.3.7 Explain your answer to QUESTION 3.3.6

Common misconceptions & Errors

SECTION B – Scientific Investigation (Evolution)

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- The scientists collected 120 lizards with similar characteristics that were around the same reproductive age in different habitats.
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- 40 lizards belonged to species **A**, 36 to species **B** and 44 to species **C**.
- Each species was kept in its cage with environmental conditions similar to their habitats.
- The height of the head was measured for each lizard and averages calculated for each species.
- Using a Kistler force, the bite force of each lizard in each species was measured five times and the average calculated for each lizard and each species.

The results are shown in the table below.

Species	Height of the head (mm)	Bite force (N)
A	10,3	12,4
B	10,7	14,3
C	13,2	20,4

3.3.6 Which species (**A**, **B** or **C**) would be expected to be feeding mainly on tough fibrous plants? C✓ (1)

3.3.7 Explain your answer to QUESTION 3.3.6

- has the strongest bite force✓/ 20,4N
- to break down✓ tough fibrous plant material (2)

Common misconceptions & Errors

3.3.7 Candidates failed to articulate the degree of comparison between 3 species for the data given. They used *stronger* instead of *strongest*.

SECTION B – Scientific Investigation (Evolution)

3.3 An investigation was done to determine the relationship between the height of the head and bite force in lizards. The procedure was as follows:

- The scientists collected 120 lizards with similar characteristics that were around the same reproductive age in different habitats.
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3.3.8 Which species (**A**, **B** or **C**) would be most suited to live in narrow areas between the rocks?

Common misconceptions & Errors

SECTION B – Scientific Investigation (Evolution)

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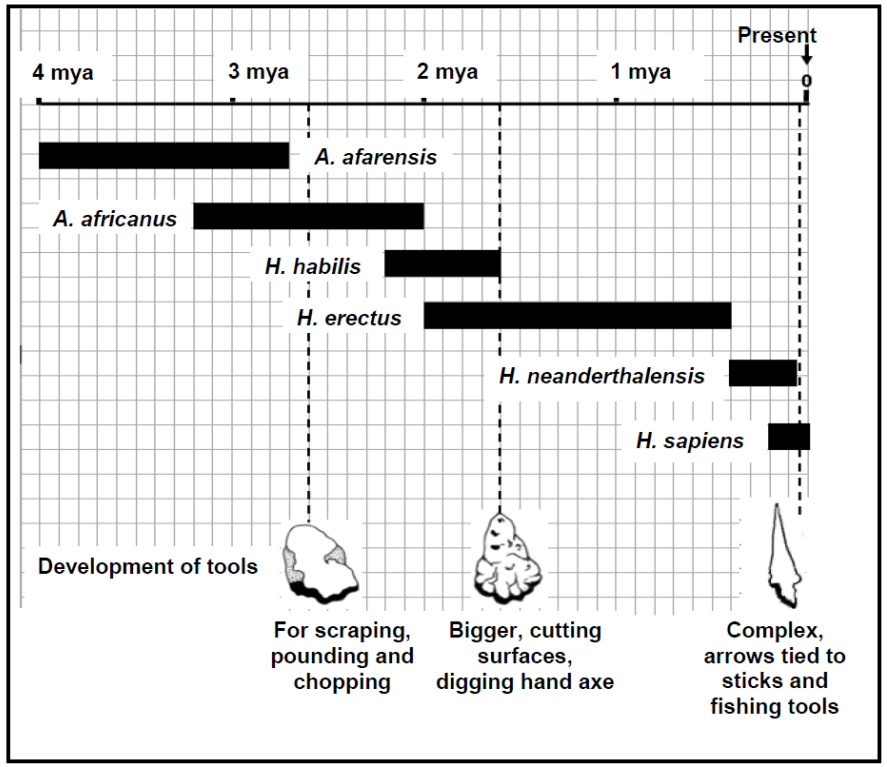
3.3.8 Which species (**A**, **B** or **C**) would be most suited to live in narrow areas between the rocks?

A✓ (1)

Common misconceptions & Errors

SECTION B – Phylogenetic Tree

3.4 The diagram shows a timeline of different hominid species and the development of tools.



3.4.1 Which species in the diagram above existed/survived for the longest period of time?

3.4.2 Calculate the period (million years) in which the *A. afarensis* and *A. africanus* coexisted. Show ALL working.

3.4.3 Name the species that was also known as the handyman.

Common misconceptions & Errors

SECTION B – Phylogenetic Tree

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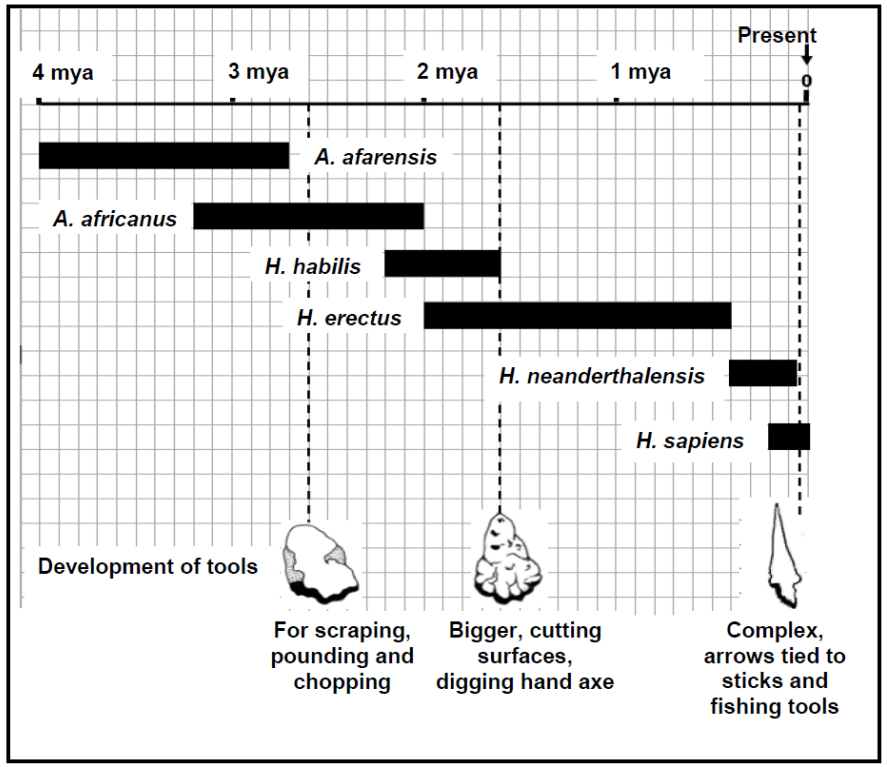

3.4.1 Which species in the diagram above existed/survived for the longest period of time?

H. erectus✓ (1)

3.4.2 Calculate the period (million years) in which the *A. afarensis* and *A. africanus* coexisted. Show ALL working.

3,2 – 2,7✓ = 0,5✓ my (2)

3.4.3 Name the species that was also known as the handyman.

H. habilis✓ (1)

Common misconceptions & Errors

3.4.1 Candidates did not write the full scientific name of a species, e.g. only provided *erectus* instead of *Homo erectus* / *H. erectus*.

3.4.2 Candidates converted their answer to a thousand years instead of the million years specified by the instruction in the question.

SECTION B – Phylogenetic Tree

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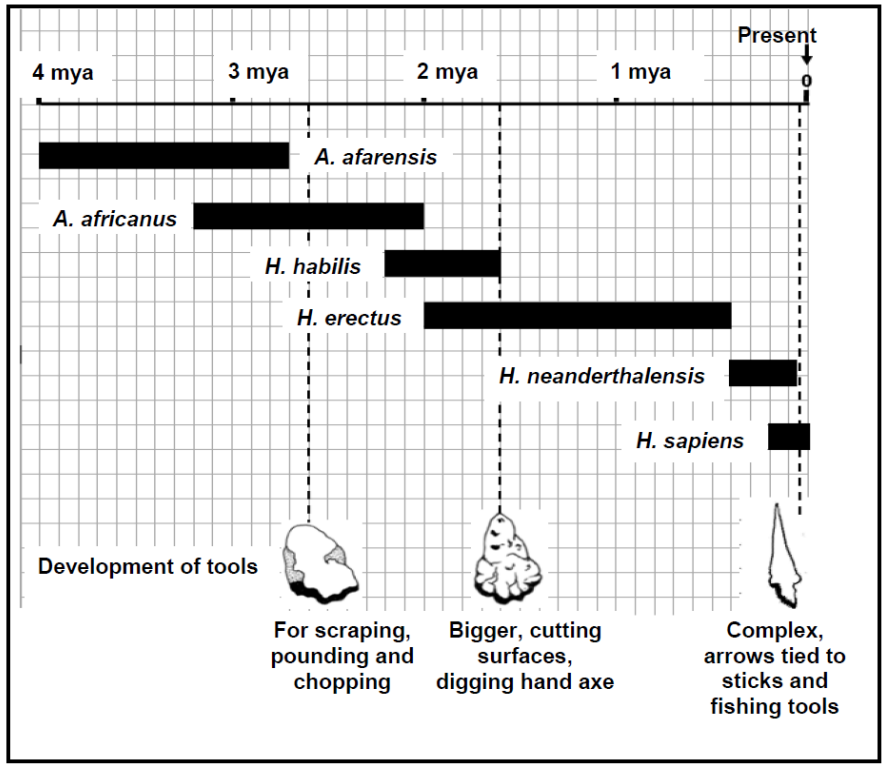

3.4.4 State TWO uses of the tool that was developed 2,6 mya.

3.4.5 Identify TWO species that used the most complex tools.

3.4.6 Explain how the changes in brain size over time relates to the development of tools.

Common misconceptions & Errors

Grade 12 Life Sciences Part 2
p. 171, 172 & 180 (2024 ed.)

SECTION B – Phylogenetic Tree

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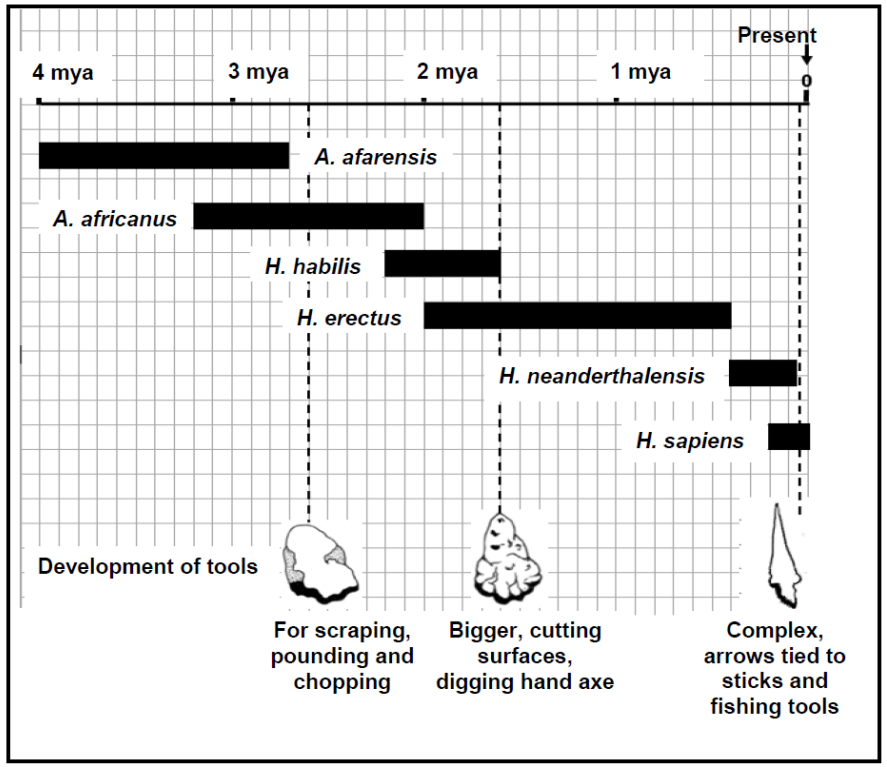


3.4.4 State TWO uses of the tool that was developed 2,6 mya.

- scraping✓
- pounding✓
- chopping✓ (first 2)

3.4.5 Identify TWO species that used the most complex tools.

- *H. sapiens*✓
- *H. neanderthalensis*✓ (first 2)

3.4.6 Explain how the changes in brain size over time relates to the development of tools.

- increased brain size✓ led to
- increased intelligence✓ leading to
- the development of complex tools✓ (3)

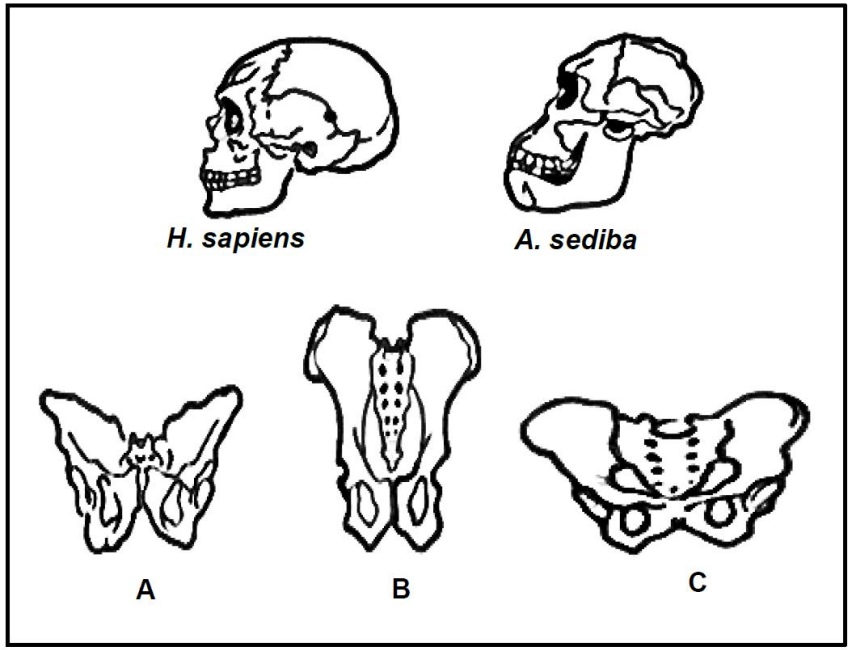
Common misconceptions & Errors

3.4.5 Candidates did not write the full scientific name of a species, e.g. only provided *sapiens* instead of *Homo sapiens* / *H. sapiens*.

3.4.6 Candidates could not explain the relationship between the change in the brain volume and the development of tools. Most wrote about an *increased brain size leading to higher thought processes*.

SECTION B – Human Evolution

3.5 The diagrams below show the skulls and pelvises of different hominids.



3.5.1 State the genus name of *A. sediba.*

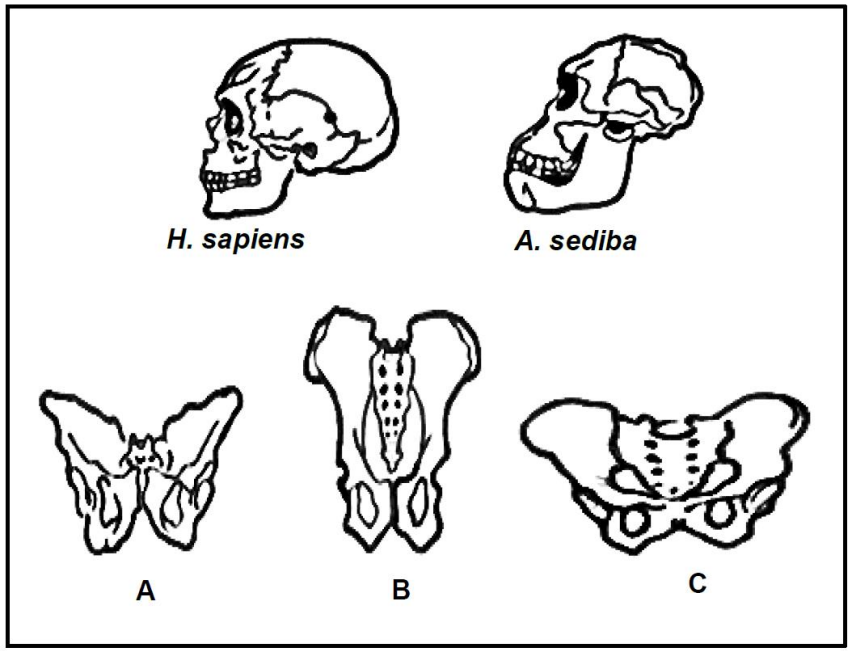
3.5.2 Describe the shape of the spine of *H. sapiens.*

3.5.3 *A. sediba* is thought to be a transitional species. State what is meant by a *transitional species.*

Common misconceptions & Errors

SECTION B – Human Evolution

3.5 The diagrams below show the skulls and pelvises of different hominids.



3.5.1 State the genus name of *A. sediba.*

Australopithecus✓ (1)

3.5.2 Describe the shape of the spine of *H. sapiens.*

S✓-shaped spine (1)

3.5.3 *A. sediba* is thought to be a transitional species. State what is meant by a *transitional species.*

- an organism that has intermediate/common characteristics✓
- between two genera✓ /species (2)

Common misconceptions & Errors

3.5.3 Candidates could not describe a transitional species. This indicated that they were not familiar with the concept of a transitional species and they were further disadvantaged in 3.5.4 and 3.5.5 which were follow-up questions.

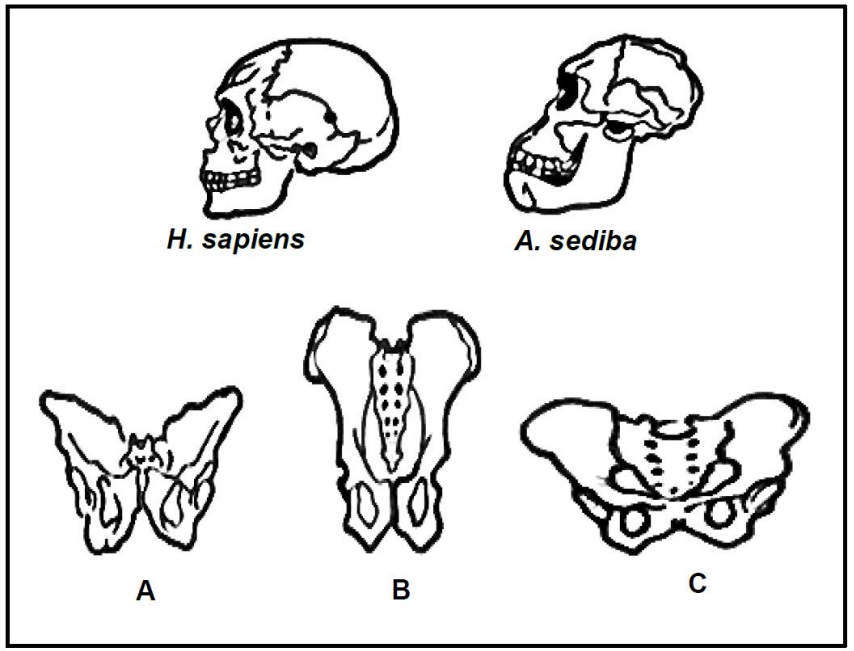
They incorrectly described it as having characteristics of *two organisms* ✖ instead of having *common/intermediate characteristics between two species* (ancestral/descendant and predecessor).

SECTION B – Human Evolution

3.5 The diagrams below show the skulls and pelvises of different hominids.

3.5.4 Give the LETTER of the pelvis that would be representative of *A. sediba.*

3.5.5 Explain your answer to QUESTION 3.5.4.



3.5.6 Explain the significance of the change in prognathism from *A. sediba* to *H. sapiens*.

Common misconceptions & Errors

SECTION B – Human Evolution

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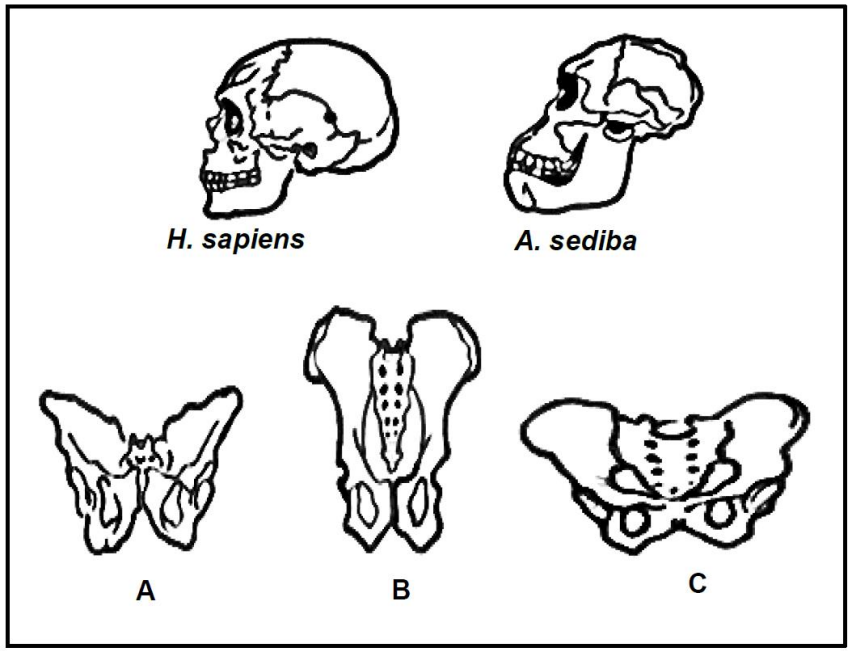


3.5.4 Give the LETTER of the pelvis that would be representative of *A. sediba.*

A✓ (1)

3.5.5 Explain your answer to QUESTION 3.5.4.

A has a pelvis that is intermediate✓ /transitional between B and C✓ OR

A has a shorter and wider pelvis than B✓ but not as short and wide as C✓ OR

A has a longer and narrower pelvis than C✓ but not as long and narrow as B✓ (2)

3.5.6 Explain the significance of the change in prognathism from *A. sediba* to *H. sapiens*.

- *A. sediba* was prognathous✓/more prognathous while
- *H. sapiens* are non-prognathous✓/less prognathous
- this is due to a smaller jaw✓
- with smaller teeth✓ and
- reduced chewing muscles✓
- caused by a changed diet to eating soft/cooked food✓ (any 5)

Common misconceptions & Errors

3.5.4 & 3.4.5 Candidates were further disadvantaged in 3.5.4 and 3.5.5 which were follow-up questions to 3.5.3.

3.5.6 Candidates were not familiar with the term *prognathism*, because most stated the general structural differences between African apes and humans.

Some candidates focused their response on *A. sediba* and failed to explain the significance of the change for *H. sapiens.*

SECTION B QUESTION 3 – Suggestions for improvement

☑ Biotechnology involves the manipulation of genes of an organism.

- *Genetic engineering, e.g. when a gene is taken from one organism and inserted in another organism → involves a single gene inserted into an organism*
- *Artificial selection, e.g. when a donkey is interbred with a horse → involves interbreeding of whole organisms*

☑ Higher thought process is a function of the cerebrum whether its volume is large or small.

- *When the brain volume increases, the higher thought processes also increased*
- *Most organisms have some intelligence that enables them to survive in their environments*
- *Therefore, an increased brain volume led to an increased intelligence / increased higher thought processes and therefore, more complex tools were developed as a result*

☑ A *transitional species* displays the *intermediate/common characteristics* between a predecessor (which comes before it) and a descendent (which derives/comes after it).

Revised in 2022 Paper 2 Diagnostic Report T & L Tool

SECTION B QUESTION 3 – Suggestions for improvement

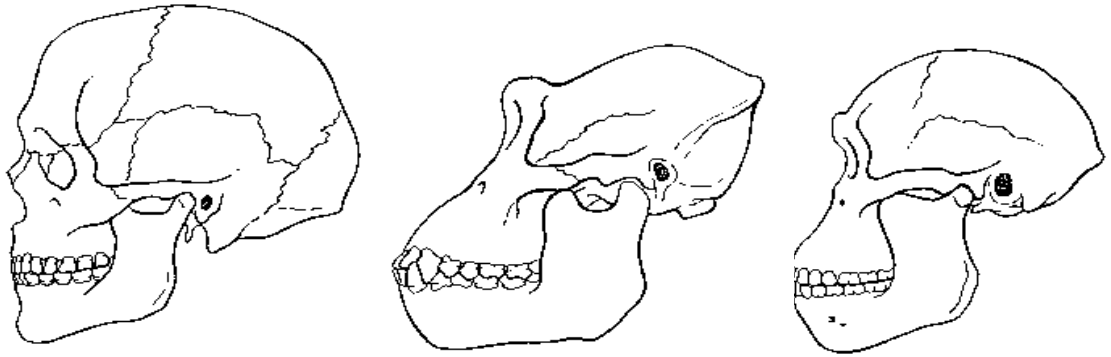
☑ The principles of taxonomy need to be thoroughly covered in Grade 10 in preparation for human evolution in Grade 12.

Revised in 2022 Paper 2 Diagnostic Report T & L Tool

- *The terms genus (plural genera) and species must be consolidated thoroughly*
- *Learners must be instructed in scientific nomenclature; that when a species name is requested that both the genus and species must be provided*

☑ Know how to use the term *prognathism*.

- *When given skulls that are clearly sloped vs not, state which one is prognathous or non-prognathous*
- *When given skulls that all display some prognathism, state which is more prognathous or less prognathous*



X **Y** **Z**

Comparing X and Y: *X is non-prognathous; Y is prognathous*

Comparing Y and Z: *Y is more prognathous; Z is less prognathous*

Comparing X, Y and Z: *X is non-prognathous; Y and Z are prognathous where Y is more prognathous than Z*

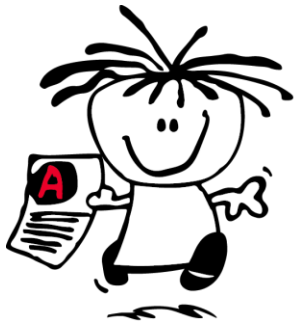
Suggestions for improvement in Paper 2 Concepts

- ☑ Place more emphasis on scientific investigations and their design.
  - *Learners should be **taught the value of each design element** and **how it contributes to a valid investigation.***

Revised in 2023 Paper 1 Diagnostic Report T & L Tool

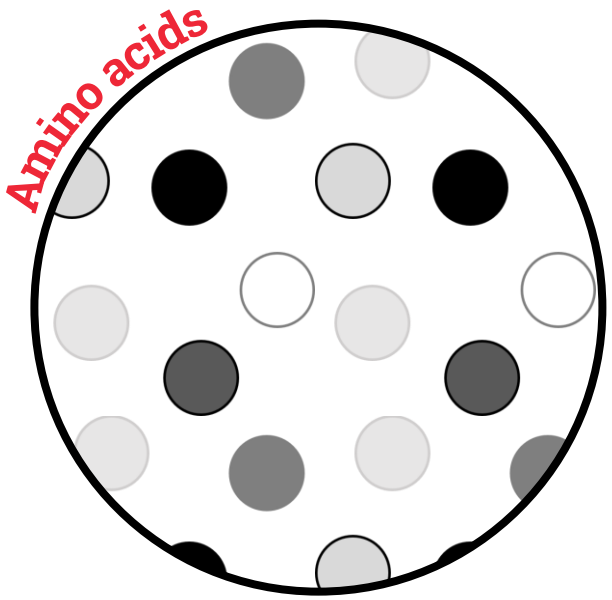
- ☑ Learn the sequence of steps describing natural selection as stated in the Exam Guidelines.
  - *Be able to apply this generic process to the source material provided*
  - *Tailor answers to the context of the question*
- ☑ Open-ended questions should be asked in both formal and informal tasks for learners to understand that when opinions are requested, these should be relevant.
- ☑ Increase exposure to questions involving lengthy texts, to practice reading with understanding and constructing precise responses.
- ☑ Read the stem of the question, as this provides guidance on the responses expected from the information given.
- ☑ Do not provide responses in a negative form, e.g.
  - *Q: 'What is an autosome?'*
  - *A: 'It is not a sex chromosome.'* ✖

END

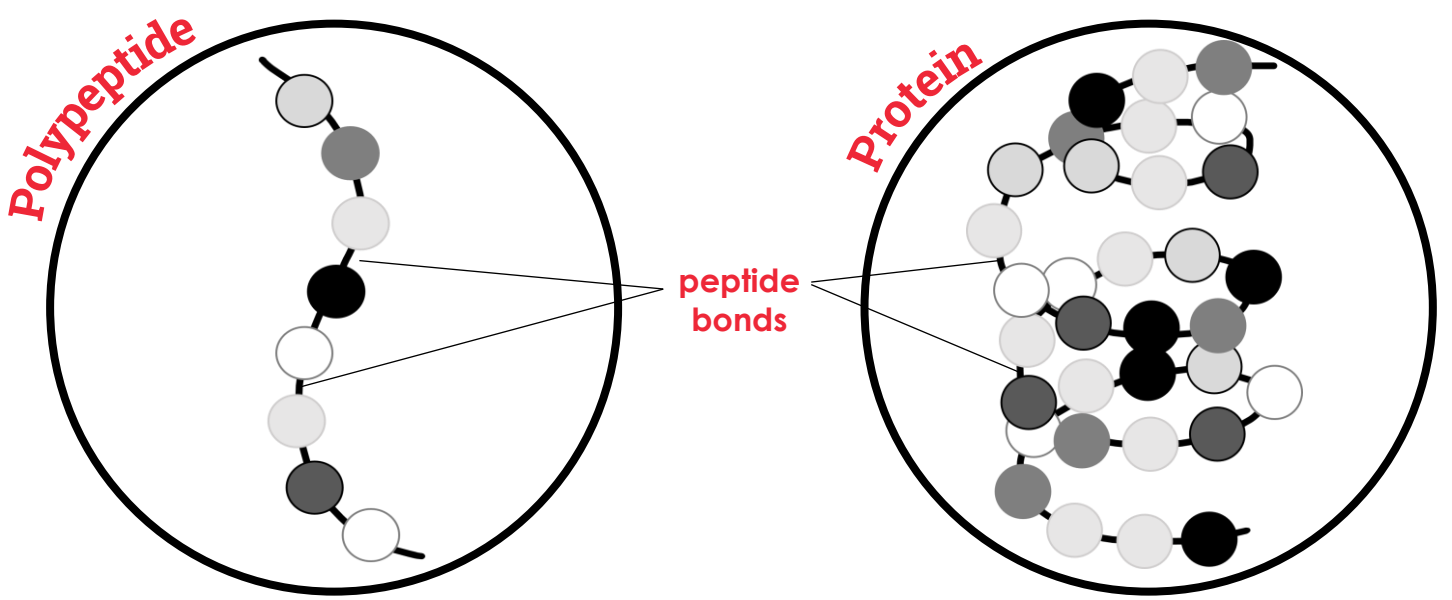


THE ANSWER SERIES *Your Key to Exam Success*

COMMONLY CONFUSED TERMS – Peptide bond vs Polypeptide vs Protein

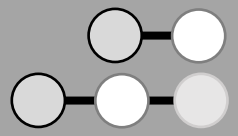


- ✓ Building blocks of proteins.
- ✓ There are 20 different amino acids.
- ✓ The type and sequence of amino acids determine the type of protein.



- ✓ A shorter chain of more than three, but less than 50, amino acids linked together by peptide bonds.

REMEMBER



dipeptide (2 amino acids)

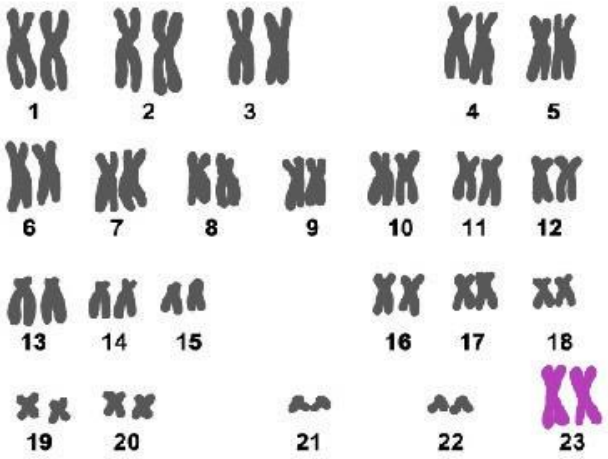
tripeptide (3 amino acids)

- ✓ A longer chain of more than 50 amino acids linked together by peptide bonds.
- ✓ Proteins are polymers (large molecules) made from amino acids which are their monomers.

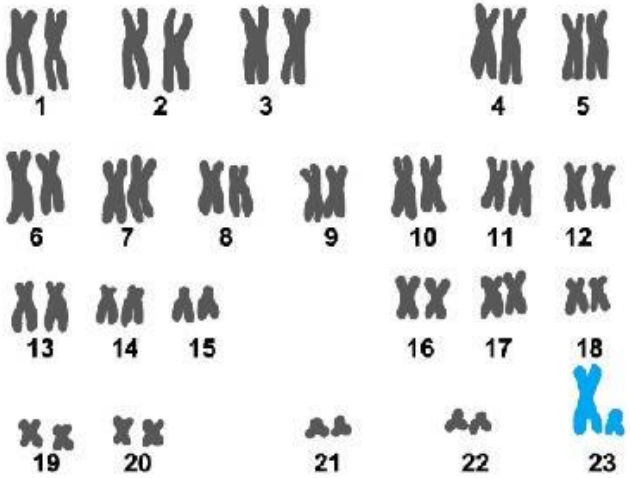
Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 15

Continue learning – autosomes vs gonosomes

COMMONLY CONFUSED TERMS – Autosomes vs Gonosomes



Normal female karyotype (44 + XX)



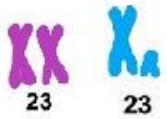
Normal male karyotype (44 + XY)

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 23

Autosomes

- ✓ Chromosomes that are **not involved in sex determination**.
- ✓ Chromosome **pairs 1 to 22** / the **first 22 chromosome pairs**.
- ✓ Humans have **44 autosomes**.

Gonosomes



- ✓ Chromosomes **involved in sex determination**, i.e. X or Y.
- ✓ Chromosome **pair 23** / the **last chromosome pair**.
- ✓ **Females** have an **XX** pair.
- ✓ **Males** have an **XY** pair.

NOTE

*The **XX chromosomes** of females are considered **homologous** chromosomes, but the **XY chromosomes** of males are **not**.*

Continue learning – phenotype vs genotype

COMMONLY CONFUSED TERMS – Phenotype vs Genotype

Phenotype

- ✓ The **physical appearance** (visible traits) of an organism.
- ✓ These observable characteristics in the phenotype are **determined by the genotype** as well as the environment.

Genotype

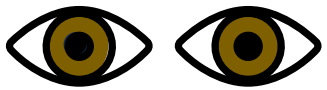
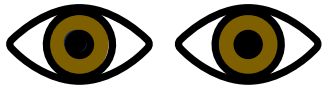
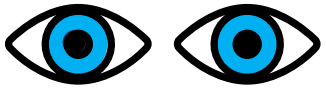
- ✓ The **genetic composition** of an organism for a given trait/characteristic.
- ✓ Determined by alleles (gene pairs) carried on homologous chromosomes.
  - ➢ If the two **alleles** (gene pair) are **the same**, e.g. **BB** or **bb**, the genotype is described as **homozygous** for that specific characteristic.
  - ➢ If the two **alleles** (gene pair) **differ** from one another, e.g. **Bb**, the genotype is described as **heterozygous** for that specific characteristic.

NOTE

Characteristics are visible features of an organism, e.g. eye colour. Traits are specific variations of characteristics, e.g. blue eyes and brown eyes.

NOTE

The phenotype only describes the variation of the trait, i.e. blue eyes or brown eyes. The genotype describes the composition of the alleles, i.e. homozygous, heterozygous, etc.

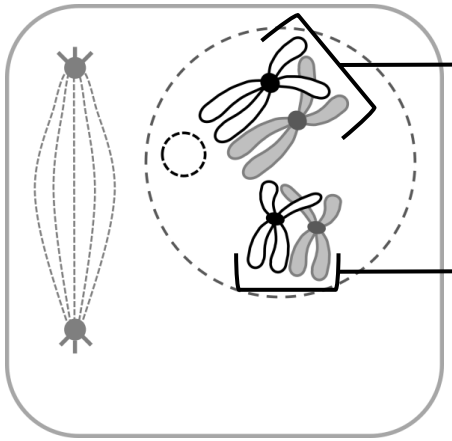
Phenotype	 *brown eyes*	 *brown eyes*	 *blue eyes*
Genotype	**BB** *homozygous dominant*	**Bb** *heterozygous*	**bb** *homozygous recessive*

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 43 – 44

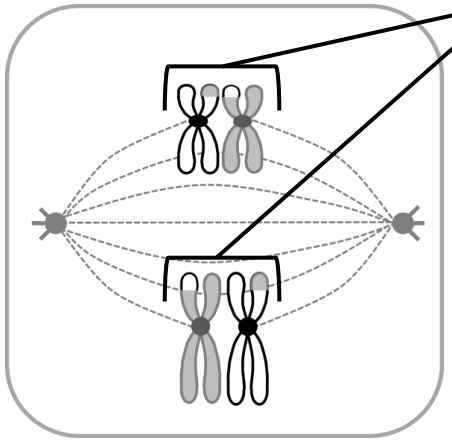
Continue learning – bivalent vs homologous chromosome pair

COMMONLY CONFUSED TERMS – Bivalent vs Homologous Chromosome Pair

Prophase I



Metaphase I



Bivalent

- ✓ A term used to describe homologous chromosomes when the chromatids overlap during crossing over.
- ✓ After crossing over has been completed, the homologous chromosomes are no longer called a bivalent.

NOTE

Rather do not use the term 'bivalent' in exams and stick to using 'homologous chromosome pair'.

Homologous chromosome pair

- ✓ A pair of chromosomes, one paternal (from the father) and one maternal (from the mother).
- ✓ They are the same size and shape, with centromeres at the same position and carry corresponding genes for the same characteristic at the same position.

COMMONLY CONFUSED TERMS – Desirable vs Favourable Characteristic

Desirable characteristic

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 74 – 79 & 151 – 152

- ✓ A term used in the context of **artificial selection** and **genetic engineering**.
- ✓ **Artificial selection** involves the **deliberate** breeding of superior individuals with desirable characteristics, e.g.:
  - Farmers select and cross breed plants/animals in such a way that each new generation will have the most desirable characteristics of the parents
  - Each new generation will have a higher proportion of individuals with these desirable characteristics
- ✓ **Genetic modification** uses the **direct manipulation of genes** to produce desirable characteristics, e.g.:
  - Scientists identify and isolate genes for the most desirable characteristics from a variety of organisms and then artificially insert them into the cells of other organisms to create organisms with these desirable characteristics
- ✓ **Humans** are the **selecting pressure** – these characteristics are **desirable** as they suit our needs
- ✓ Desirable characteristics **do not necessarily benefit** the **survival** of the offspring/organism

Favourable characteristic

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 147 &152

- ✓ A term used in the context of **natural selection**.
- ✓ **Natural selection** involves the random **selection of individuals with characteristics** that make them **best suited for survival**, e.g.:
  - In drought conditions, nature selects for plants that have more fleshy leaves to store water (a favourable characteristic), while plants that have less fleshy leaves (unfavourable characteristic) would die
  - Each new generation will have a higher proportion of individuals with the favourable characteristics (they survive and reproduce) and fewer individuals with the unfavourable characteristics (they die)
- ✓ **Nature** is the **selecting pressure** – these characteristics are **favourable** as they increase the survival changes of an organism if environmental change occurs.
- ✓ Favourable characteristics **do benefit** the **survival** of the offspring/organism.

COMMONLY CONFUSED PROCESSES – Complete vs Co- & Incomplete dominance

Complete dominance

- ✓ One allele is **completely dominant** over another allele.
- ✓ The **dominant** allele masks the expression of the recessive allele in a **heterozygote**.
- ✓ If present, the dominant allele will always be visible (expressed) in the phenotype.
- ✓ The **recessive allele** will only be visible (expressed) in a **homozygote**.

Fur colour in mice; Black (**B**) and White (**b**)

Phenotype	black fur	white fur
Genotype	**BB** or **Bb**	**bb**

Co-dominance

- ✓ Both alleles are **equally dominant**.
- ✓ Both alleles are visible (expressed) in the phenotype of a heterozygote.
- ✓ Both alleles are **expressed equally in** a **heterozygote**.
- ✓ The traits of the **individual alleles** are only **visible** (expressed) in a **homozygote**.

Fur colour in mice; Black (**B**) and White (**W**)

Phenotype	black fur	white fur	white fur with black spots
Genotype	**BB**	**WW**	**BW**

Incomplete dominance

- ✓ **Neither** allele is completely **dominant** over another.
- ✓ An **intermediate** (blended) **phenotype** is visible (expressed) in a **heterozygote**.
- ✓ The traits of the **individual alleles** are only **visible** (expressed) in a **homozygote**.

Fur colour in mice; Black (**B**) and White (**W**)

Phenotype	black fur	white fur	grey fur
Genotype	**BB**	**WW**	**BW**

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 50 – 53

Continue learning – artificial selection vs genetic engineering

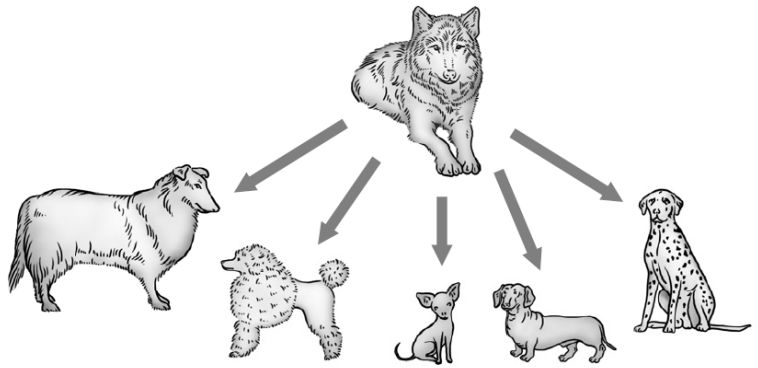
THE ANSWER SERIES *Your Key to Exam Success*

COMMONLY CONFUSED PROCESSES – Artificial Selection vs Genetic Engineering

Artificial selection

- ✓ **Artificial selection** involves the **deliberate** breeding of superior individuals with desirable characteristics, e.g.:
  - Farmers select and cross breed plants/animals in such a way that each new generation will have the most desirable characteristics of the parents.
  - Involves **interbreeding of whole organisms** with each other.

Grey wolf (*Canis lupus*)



The origin of domestic dogs through artificial selection

Genetic engineering

- ✓ Genetic engineering is an application of **Biotechnology**. It is also known as **Genetic modification**.
- ✓ **Genetic modification** uses the **direct manipulation of genes** to produce desirable characteristics, e.g.:
  - Scientists identify and isolate genes for the most desirable characteristics from a variety of organisms and then artificially insert them into the cells of other organisms to create organisms with these desirable characteristics.
  - Usually involves the insertion of a **single gene into an organism**.

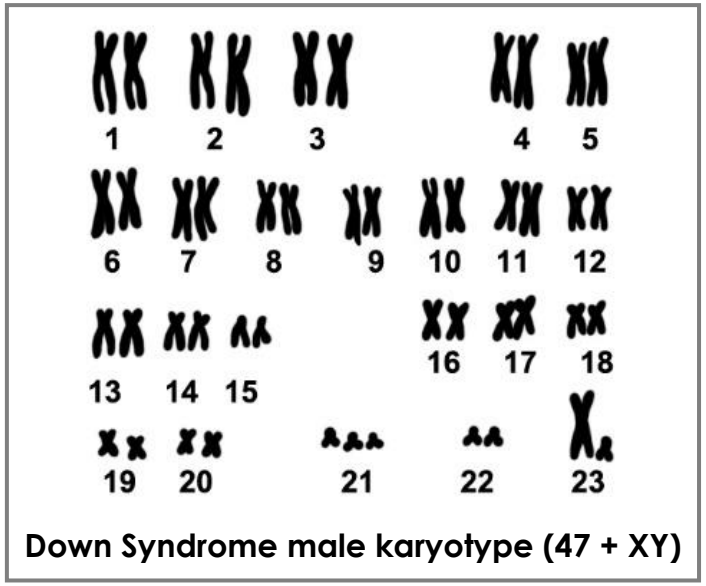
Hans-Petter Fjeld, CC BY-SA 2.5 via Wikimedia Commons

Aqua advantage salmon have modified growth hormone regulating genes so that it grows to market size in less time

COMMONLY CONFUSED PROCESSES – Chromosome mutation vs Gene mutation

Chromosome mutation

- ✓ A **change in** the **structure or number of chromosomes** of a cell.
- ✓ Diseases for NSC: **Down Syndrome**
  - Cells have an **extra copy of chromosome 21** (trisomy-21) with a total of **47 chromosomes** in each somatic cell

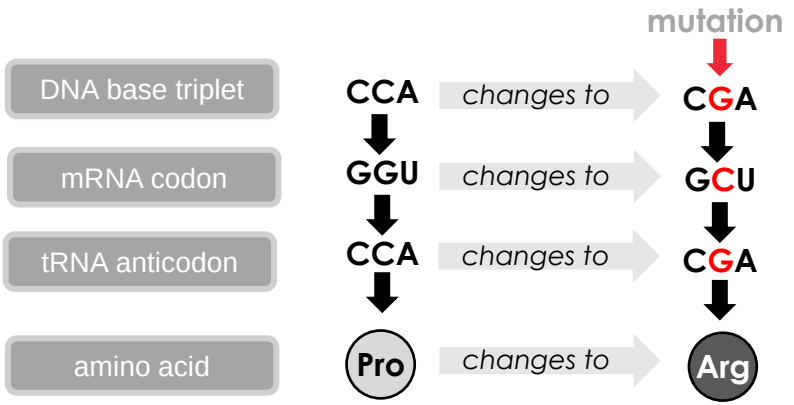


Down Syndrome male karyotype (47 + XY)

Chromosome mutation

Gene mutation

- ✓ A **change in** the **sequence of nitrogenous bases** in DNA.
- ✓ Diseases for NSC: **Albinism**, **Colour-blindness** and **Hemophilia**
  - changes in the **base triplet sequence** on the **DNA**
  - may change the **codon sequence** on the **mRNA**
  - may change the **anticodon sequence** on the **tRNA**
  - may change the **amino acid sequence** of the protein
  - may change the **shape and function** of the **protein**



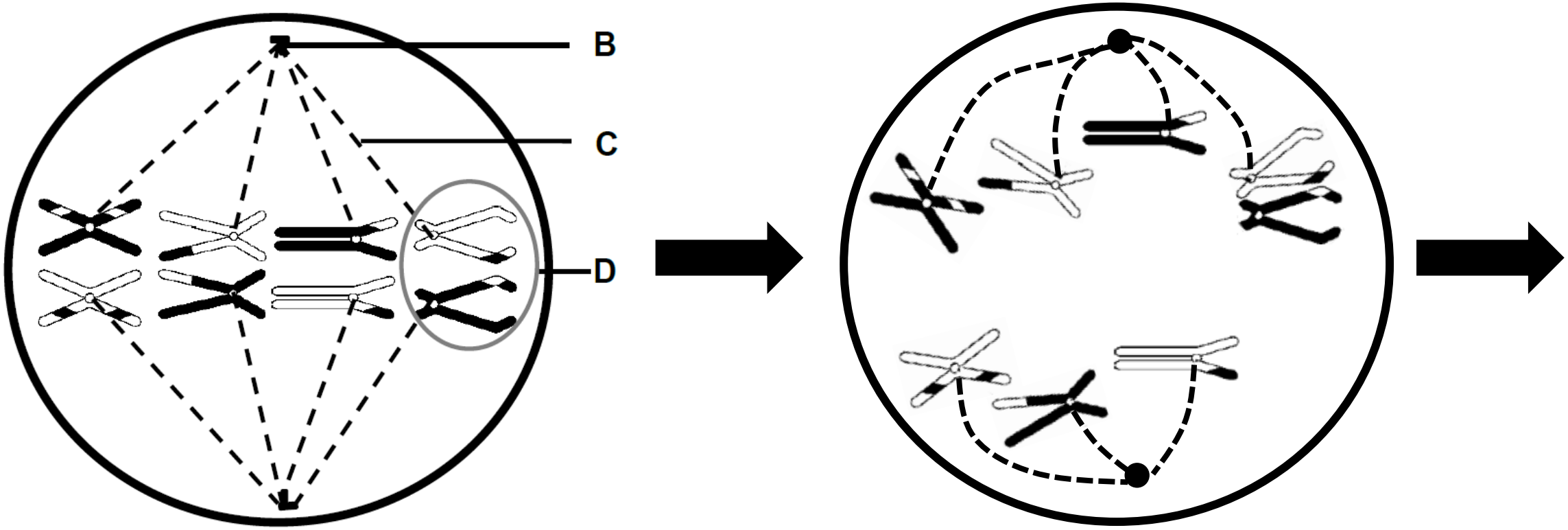
Gene mutation

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 34 and 69

THE ANSWER SERIES *Your Key to Exam Success*

QUESTION 2.1 – Visualise the phases in Meiosis

Visualise the process after the phase provided:



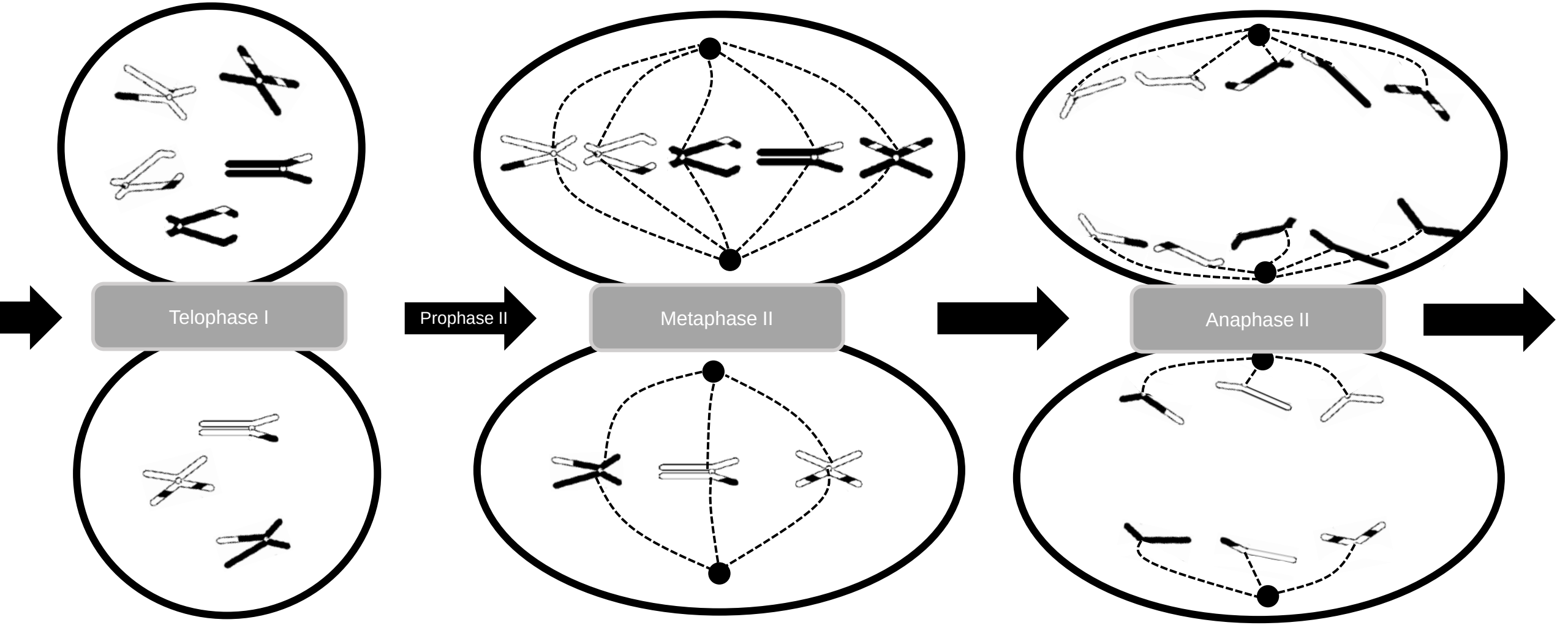
Metaphase I
(given in question)

Anaphase I

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 28 – 31

Continue learning

QUESTION 2.1 – Visualise the phases in Meiosis



Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 28 – 31

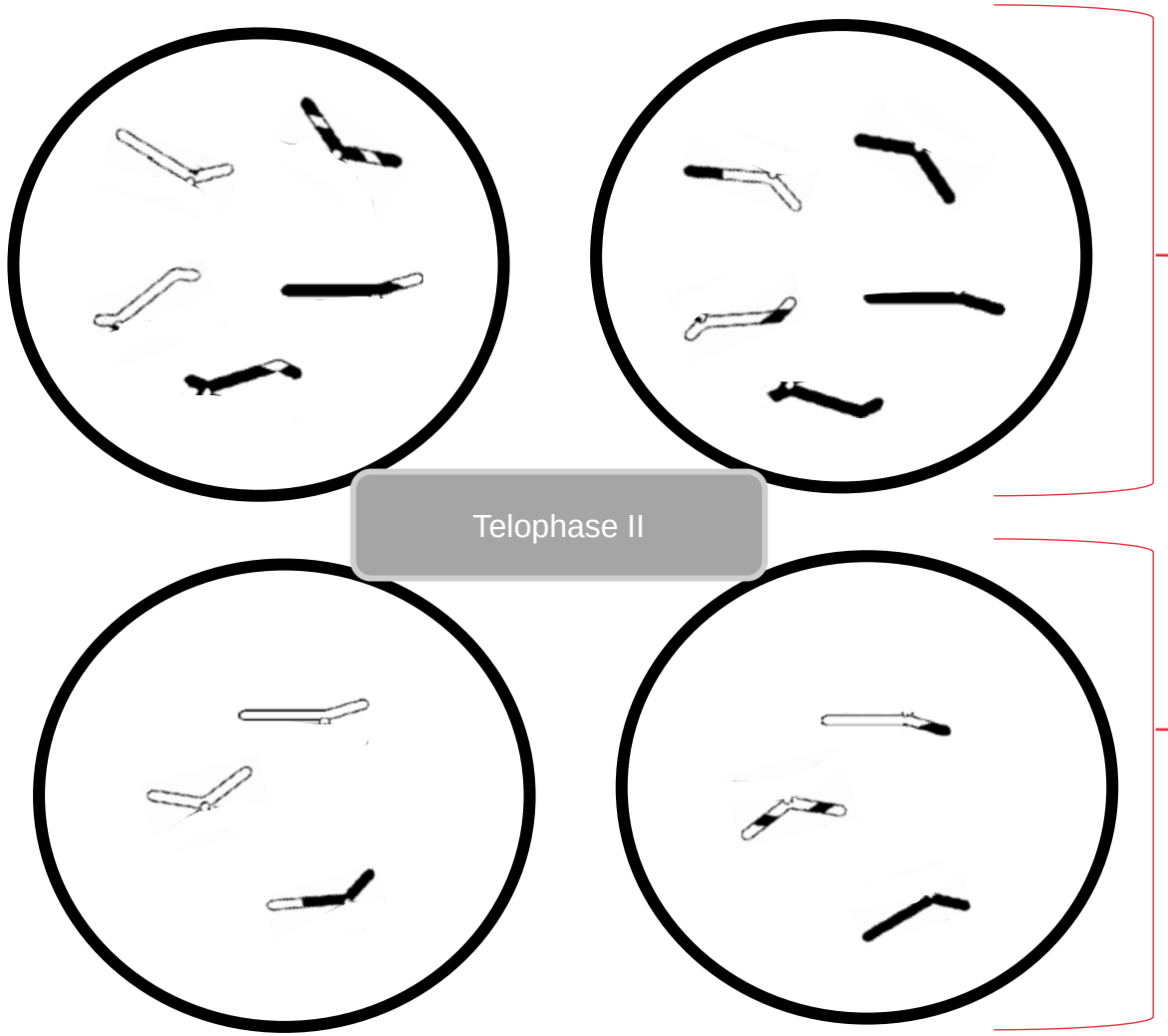
Continue learning

THE ANSWER SERIES Your Key to Exam Success

QUESTION 2.1 – Visualise the phases in Meiosis

NOTE

Take time to draw rough sketches of the steps of meiosis on a separate page for the specific example given in an exam question. It will help you visualise what happens during the phases.



Daughter cells with 5 chromosomes each

Daughter cells with 3 chromosomes each

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 28 – 31

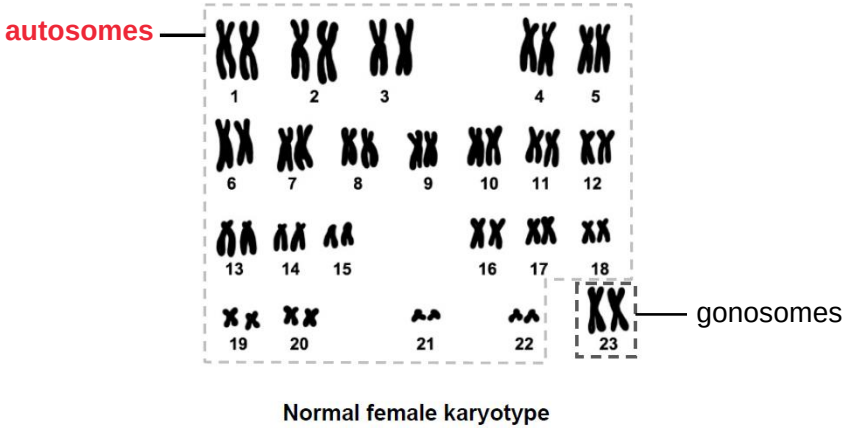
THE ANSWER SERIES *Your Key to Exam Success*

QUESTION 2.3 – Understanding genetic terminology

Understand the words used to describe genetic inheritance:

Autosomal {dominant} allele

refers to the **chromosome pairs 1 to 22** (autosomes) that are not involved in sex determination

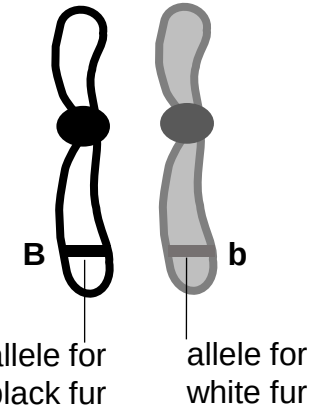


Normal female karyotype

allele will **always be visible** (expressed) in the phenotype, even when recessive allele is present, e.g. black fur:

Phenotype	black fur	black fur
Genotype	**BB**	**Bb**

alternative forms of the same gene, i.e. this implies there is also a recessive allele for this trait



Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 23, 42 – 44

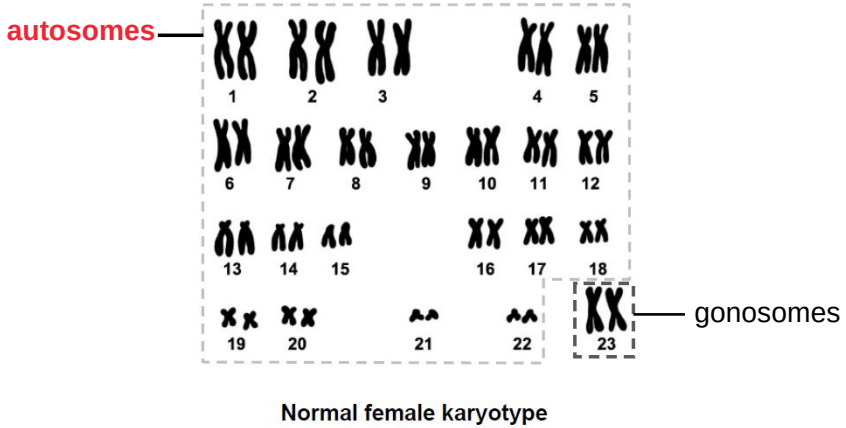
Continue learning – autosomal recessive allele

QUESTION 2.3 – Understanding genetic terminology

Understand the words used to describe genetic inheritance:

Autosomal {recessive} allele

refers to the **chromosome pairs 1 to 22** (autosomes) that are not involved in sex determination

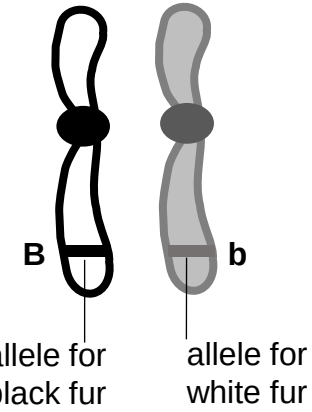


Normal female karyotype

allele will **only be visible** (expressed) in the homozygous state, e.g. white fur:

Phenotype	black fur	white fur
Genotype	**BB** or **Bb**	**bb**

alternative forms of the same gene, i.e. this implies there is also a dominant allele for this trait



Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 23, 42 – 44

Continue learning – X-linked recessive allele

QUESTION 2.3 – Understanding genetic terminology

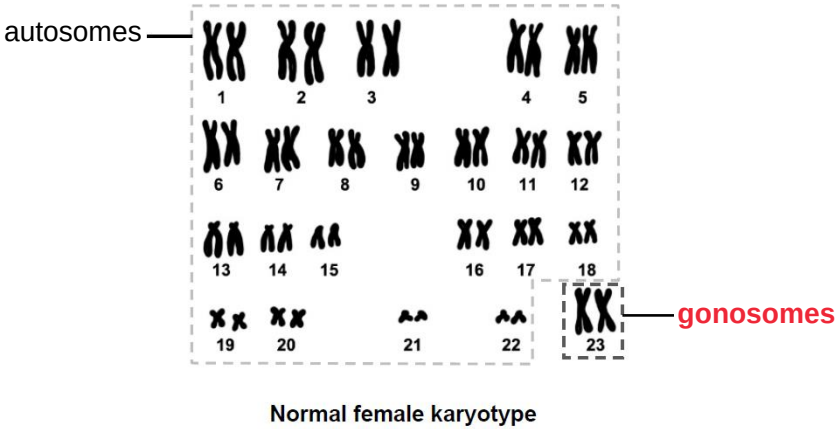
Understand the words used to describe genetic inheritance:

NOTE

X-linked genes can also be called sex-linked genes.

X-linked {recessive} allele

the allele is **linked to** the **X-chromosome** of pair 23 (gonosomes)

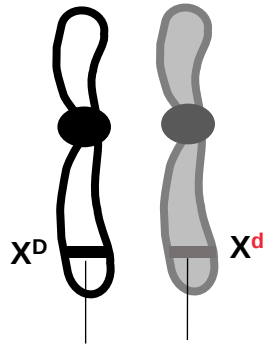


Normal female karyotype

allele is written with a **small letter attached to the X** and will **only be visible** (expressed) in the homozygous state:

Phenotype	Genotype
colour-blind female	X^dX^d
unaffected female	X^DX^D or X^DX^d
colour-blind male	X^dY
unaffected male	X^DY

alternative forms of the same gene, i.e. this implies there is also a dominant allele for this trait



allele for normal colour vision

allele colour-blindness

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 23, 42 – 44, 61 & 63

Continue learning – X-linked dominant allele

THE ANSWER SERIES *Your Key to Exam Success*

QUESTION 2.3 – Understanding genetic terminology

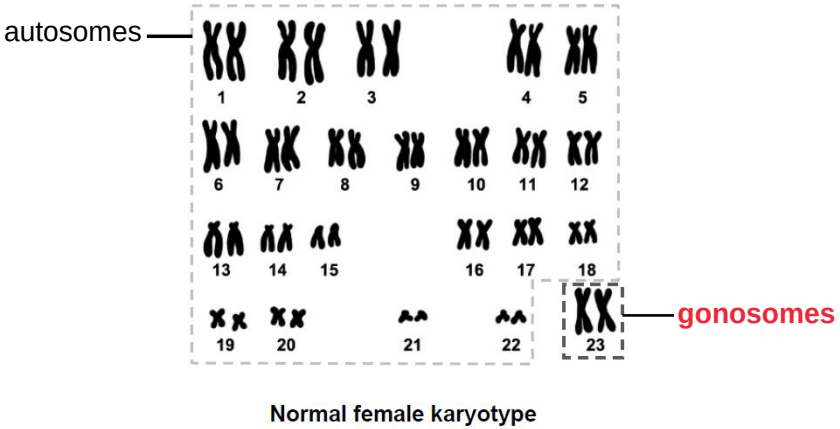
Understand the words used to describe genetic inheritance:

NOTE

X-linked genes can also be called sex-linked genes.

X-linked {dominant} allele

the allele is **linked to** the **X-chromosome** of pair 23 (gonosomes)

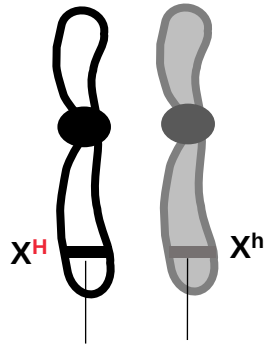


Normal female karyotype

allele is written with a **capital letter attached to the X** and will **always be visible** (expressed) in the phenotype, even when recessive allele is present:

Phenotype	Genotype
Huntington's female	X^HX^H or X^HX^h
unaffected female	X^hX^h
Huntington's male	X^HY
unaffected male	X^hY

alternative forms of the same gene, i.e. this implies there is also a recessive allele for this trait



allele for Huntington's disease

normal allele

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 23, 42 – 44, 61 & 68

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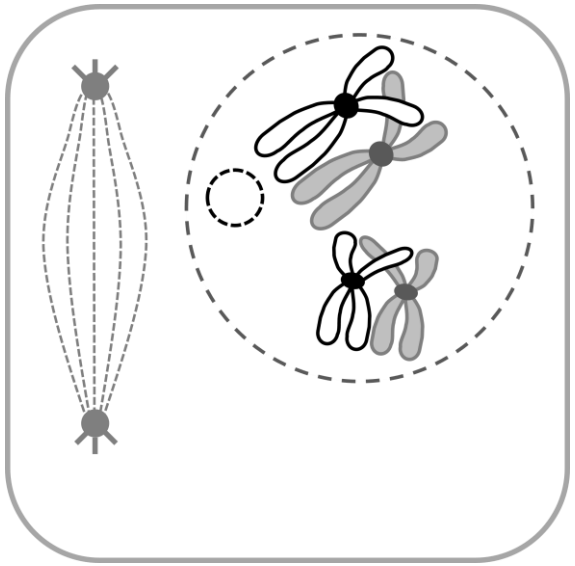
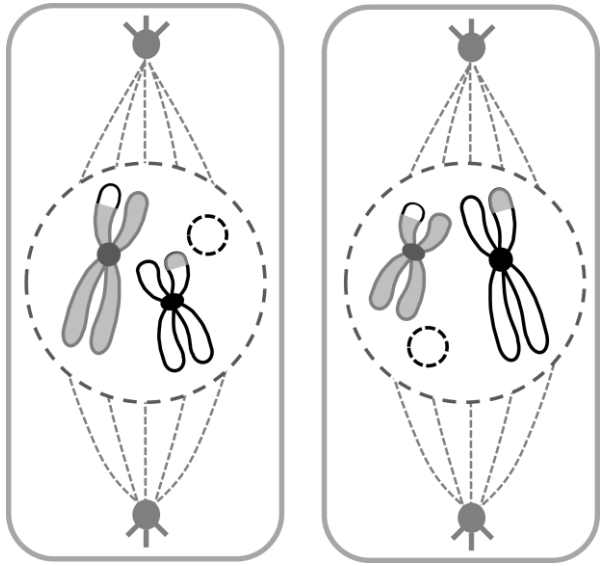
Meiosis I vs Meiosis II vs Mitosis – Prophase

Meiosis I



- ✓ chromatin network condenses
- ✓ chromosomes visible
- ✓ **chromosomes arrange into homologous pairs**
- ✓ **crossing over occurs**
- ✓ nuclear membrane and nucleolus disappear
- ✓ centrioles move to the poles and spindle fibres start to form

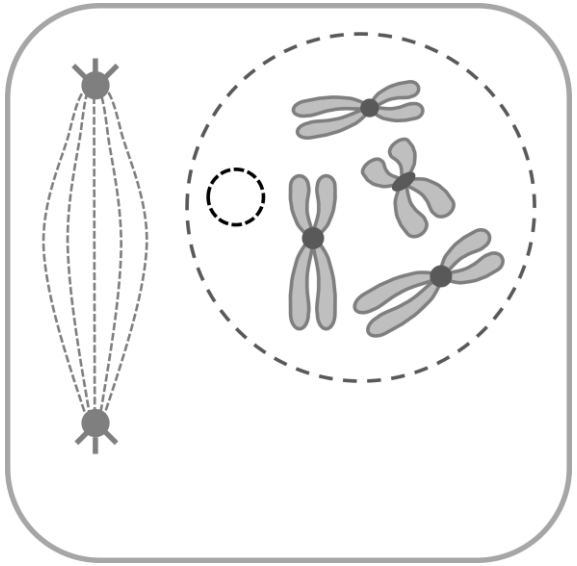
Meiosis II



- ✓ chromatin network condenses
- ✓ chromosomes visible
- ✓ nuclear membrane and nucleolus disappear
- ✓ centrioles move to the poles and spindle fibres start to form

Continue learning

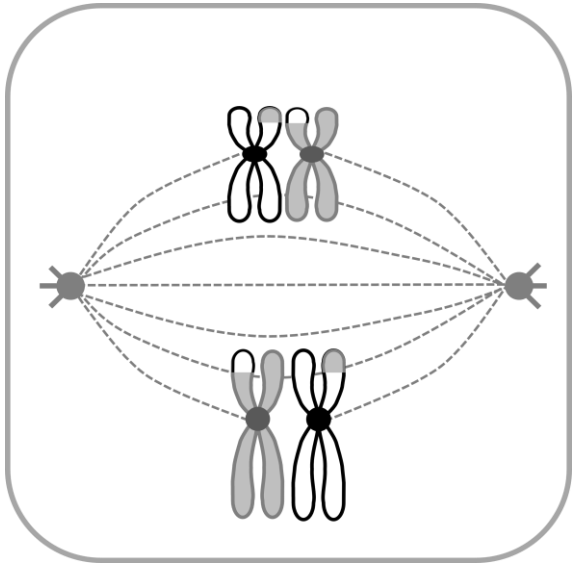
Mitosis



- ✓ chromatin network condenses
- ✓ chromosomes visible
- ✓ nuclear membrane and nucleolus disappear
- ✓ centrioles move to the poles and spindle fibres start to form

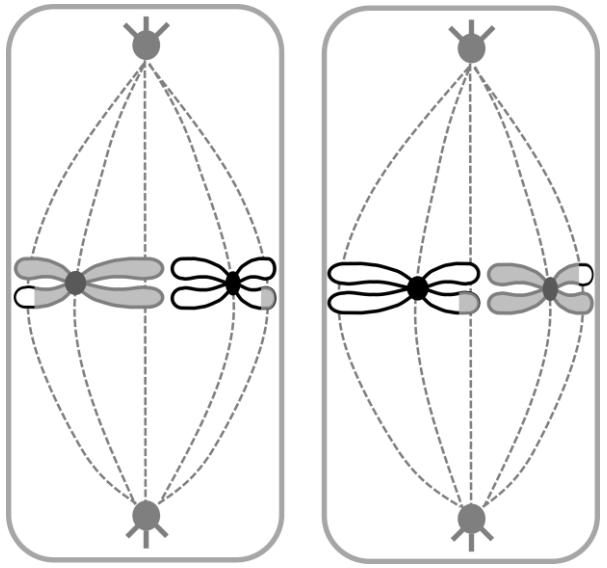
Meiosis I vs Meiosis II vs Mitosis – Metaphase

Meiosis I



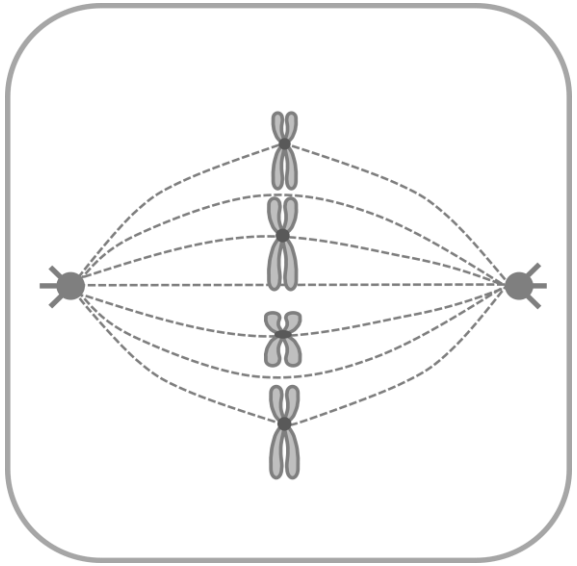
- ✓ **homologous chromosome pairs arrange on the equator of the cell**
- ✓ chromosomes **lie in a double row on the equator**
- ✓ random arrangement of chromosomes
- ✓ spindle fibres attach to the centromere of each chromosome (**only on one side**)

Meiosis II



- ✓ chromosomes **lie in a single row on the equator**
- ✓ random arrangement of chromosomes
- ✓ spindle fibres attach to the centromere of each chromosome (**on both sides**)

Mitosis

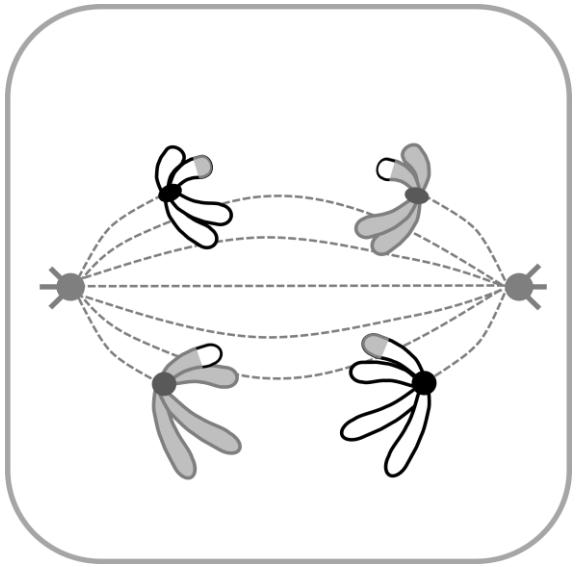


- ✓ chromosomes **lie in a single row on the equator**
- ✓ random arrangement of chromosomes
- ✓ spindle fibres attach to the centromere of each chromosome (**on both sides**)

Continue learning

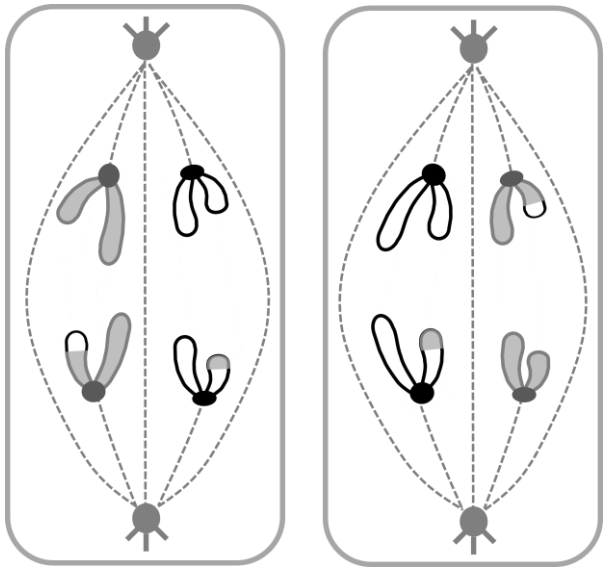
Meiosis I vs Meiosis II vs Mitosis – Anaphase

Meiosis I



- ✓ spindle fibres shorten
- ✓ **centromeres do not split**
- ✓ chromosomes of a **homologous pair are separated**
- ✓ **one replicated chromosome of each homologous pair** is **pulled towards each pole**

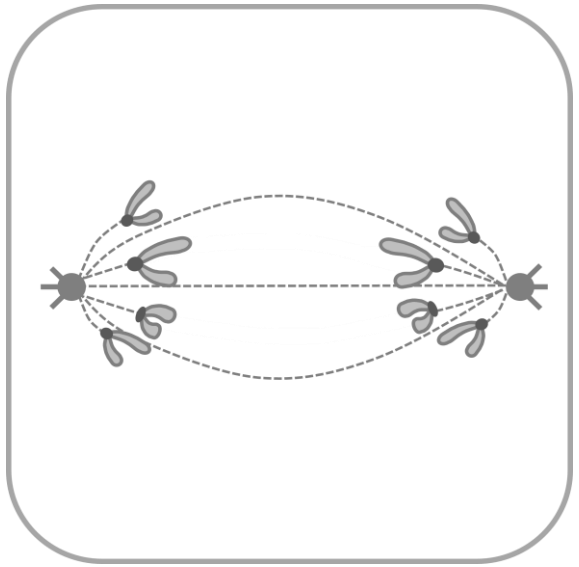
Meiosis II



- ✓ spindle fibres shorten
- ✓ **centromere** of each chromosome is **split** in two and **chromatids pulled apart**
- ✓ **unreplicated daughter chromosomes** are **pulled towards** opposite **poles**

Continue learning

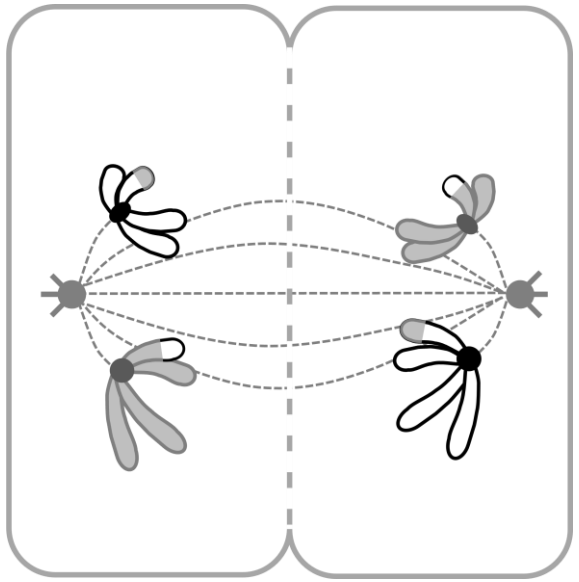
Mitosis



- ✓ spindle fibres shorten
- ✓ **centromere** of each chromosome is **split** in two and **chromatids pulled apart**
- ✓ **unreplicated daughter chromosomes** are **pulled towards** opposite **poles**

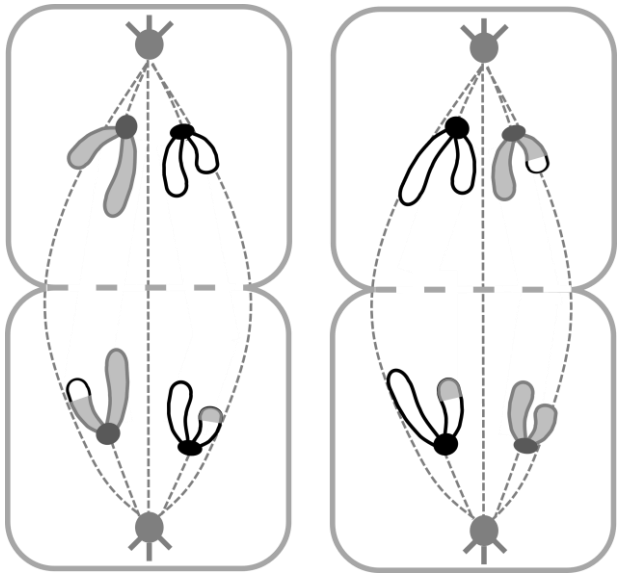
Meiosis I vs Meiosis II vs Mitosis – Telophase (early)

Meiosis I



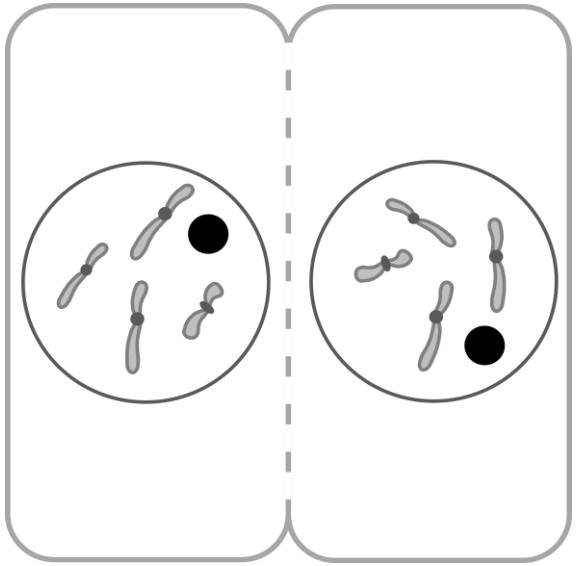
- ✓ **replicated chromosomes (double-stranded)** group **at the poles**
- ✓ **the exchange of genetic material is visible on some of the chromatids**
- ✓ spindle fibres disappear
- ✓ cytokinesis occurs: in animal cells through invagination, in plant cells through a cell plate
- ✓ **two daughter cells** are formed

Meiosis II



- ✓ **unreplicated daughter chromosomes** (single-stranded) group **at the poles**
- ✓ **the exchange of genetic material is visible on some of the chromatids**
- ✓ spindle fibres disappear
- ✓ cytokinesis occurs: in animal cells through invagination, in plant cells through a cell plate
- ✓ **four daughter cells** are formed

Mitosis



- ✓ **unreplicated daughter chromosomes** (single-stranded) group **at the poles**
- ✓ spindle fibres disappear
- ✓ cytokinesis occurs: in animal cells through invagination, in plant cells through a cell plate
- ✓ **two daughter cells** are formed

Continue learning

Meiosis I vs Meiosis II vs Mitosis – Telophase (late)

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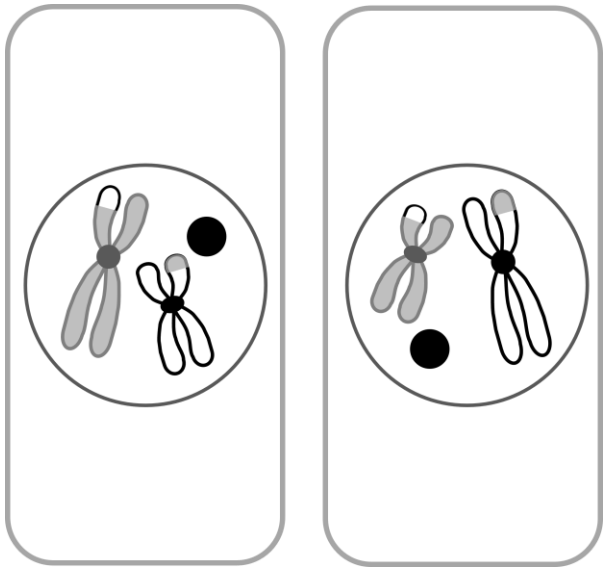
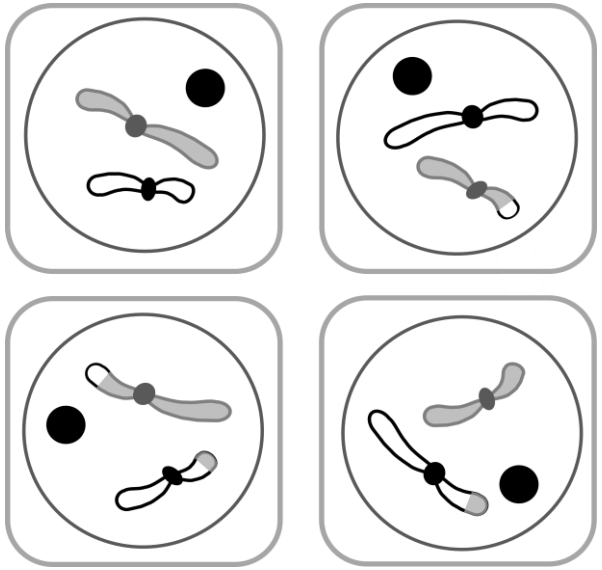
Meiosis I



- ✓ a nuclear membrane forms around each group of **replicated chromosomes** and a nucleolus reforms
- ✓ each daughter cell (**2**) has **one chromosome from each homologous pair** and **half the chromosome number** (n) of the original mother cell (2n)
- ✓ each daughter cell has a **unique genetic makeup** when compared to each other and to the original mother cell

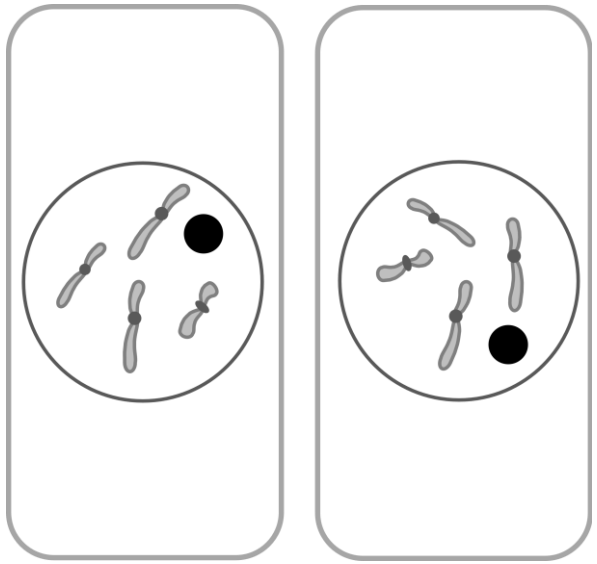
Meiosis II



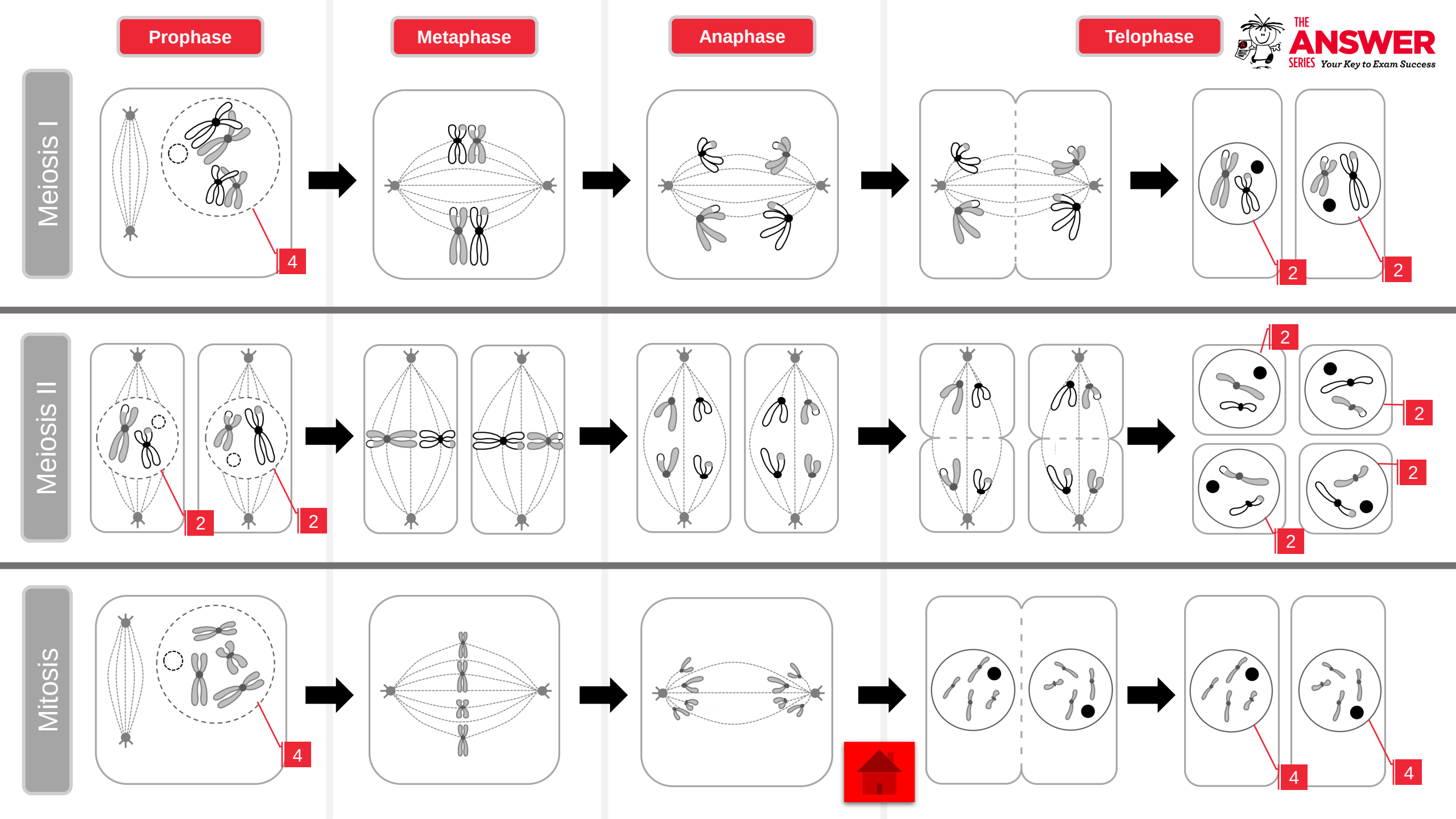
- ✓ a nuclear membrane forms around each group of **unreplicated daughter chromosomes** and a nucleolus reforms
- ✓ each daughter cell (**4**) contains only **unreplicated daughter chromosomes** and **half the chromosome number** (n) of the original mother cell (2n)
- ✓ each daughter cell has a **unique genetic makeup** when compared to each other and to the original mother cell

Continue learning

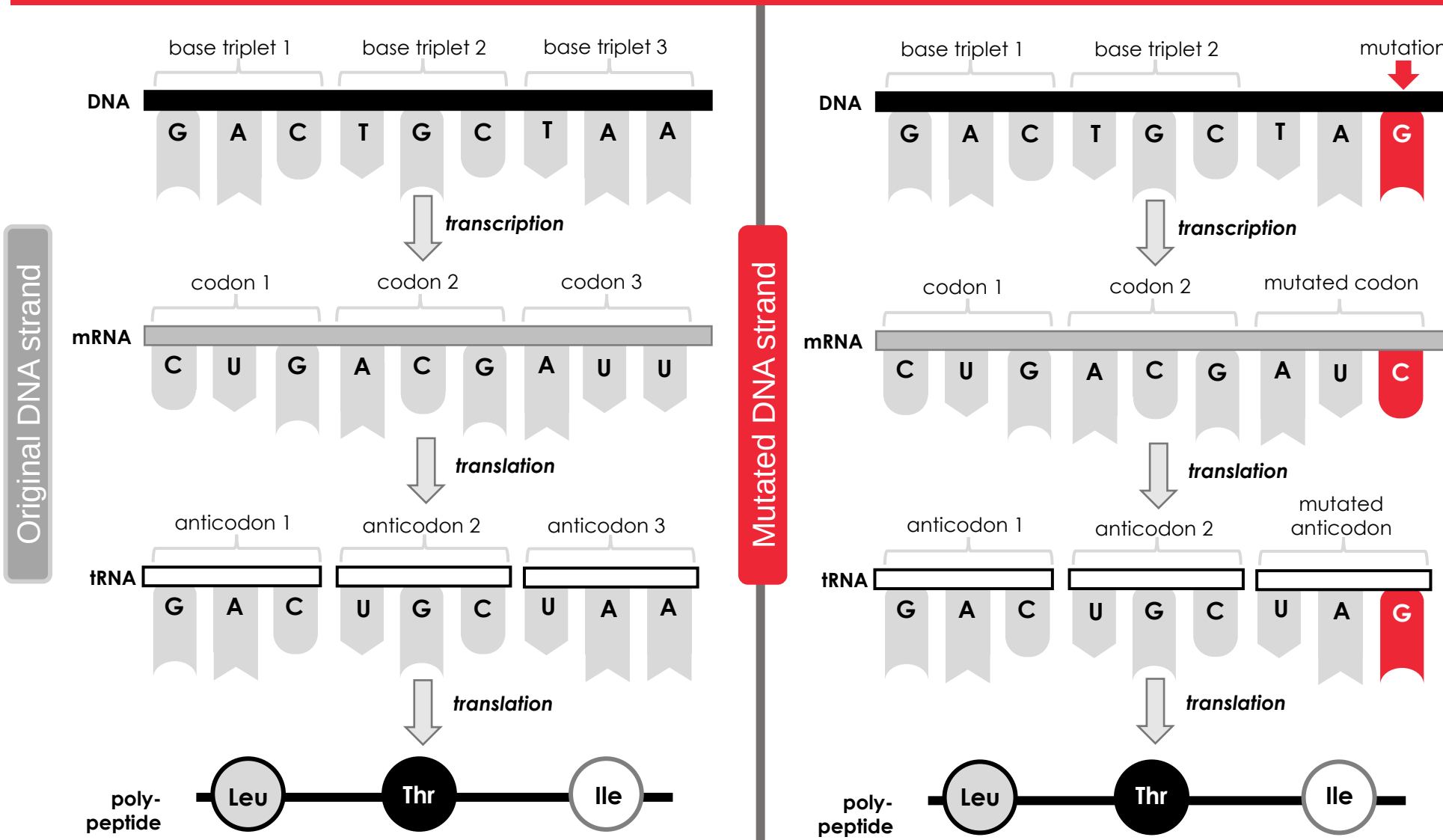
Mitosis



- ✓ a nuclear membrane forms around each group of **unreplicated daughter chromosomes** and a nucleolus reforms
- ✓ each daughter cell (**2**) contains only **unreplicated daughter chromosomes** and **the same chromosome number** (2n) as the original mother cell (2n)
- ✓ the daughter cells are **genetically identical** to each other and to the original mother cell


Prophase
Metaphase
Anaphase
Telophase
THE ANSWER SERIES Your Key to Exam Success
Meiosis I
4
2
2
Meiosis II
2
2
2
2
2
2
Mitosis
4
4
4

Understanding Mutations – Harmless mutation



mRNA codon	Amino acid
CUG	Leu
ACG	Thr
AUU	Ile
AUG	Met
AUC	Ile

NOTE

In a harmless mutation, the sequence of the amino acids in the resulting protein do not change. Therefore, the protein's structure and function do not change.

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 19 – 20

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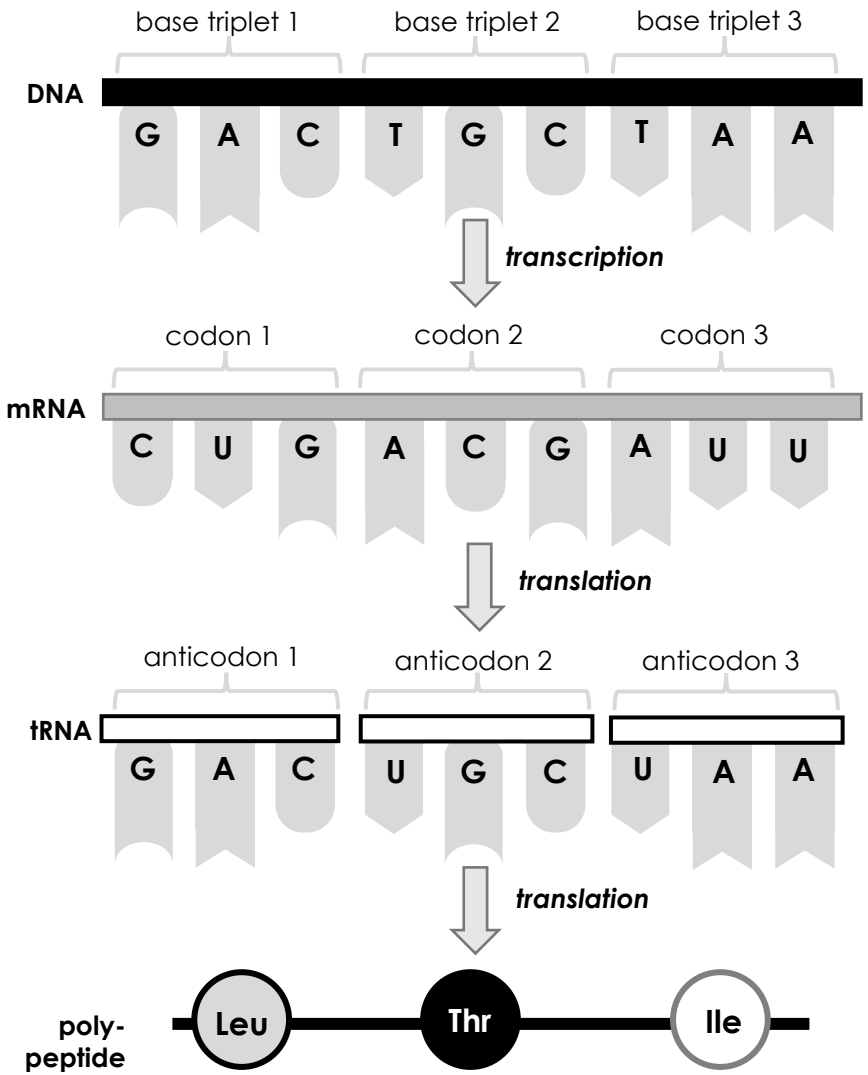
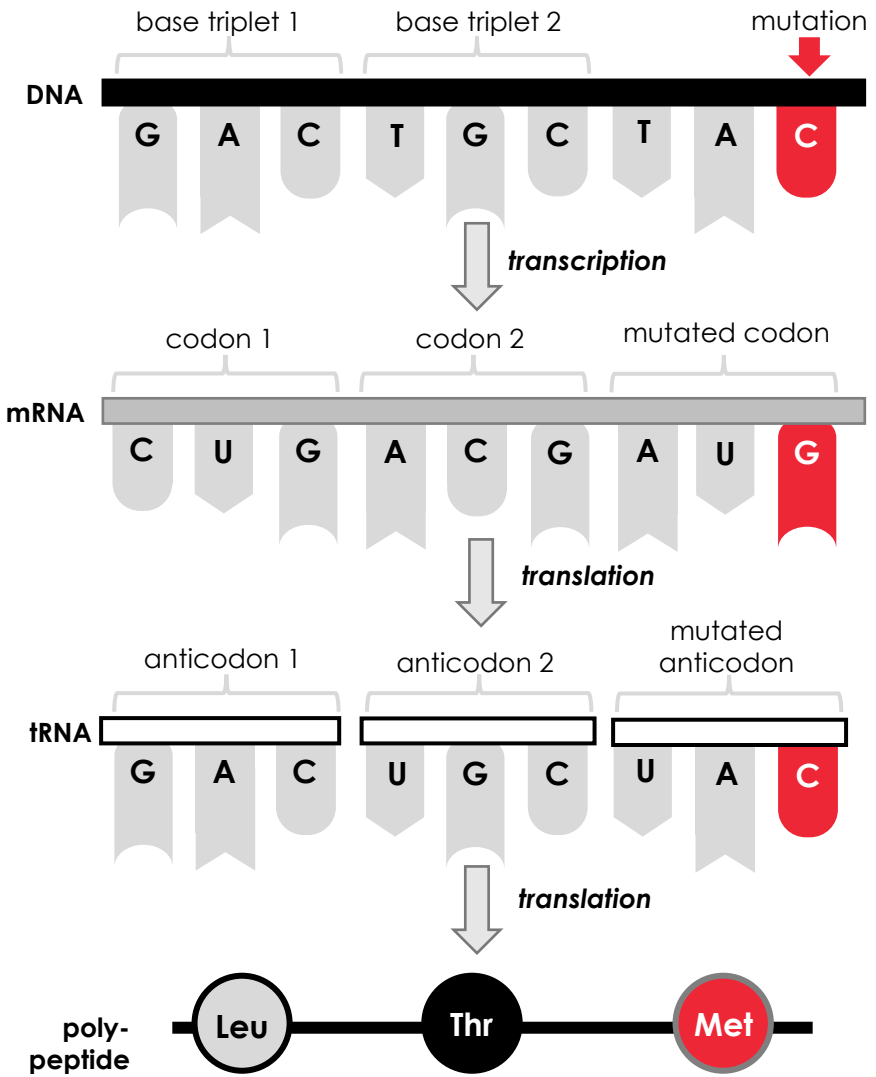
Understanding Mutations – Harmful or Beneficial mutation

Original DNA strand



Mutated DNA strand



mRNA codon	Amino acid
CUG	Leu
ACG	Thr
AUU	Ile
AUG	Met
AUC	Ile

NOTE

In a harmful or beneficial mutation, the sequence of the amino acids in the resulting protein change. Therefore, the protein's structure may change and it may either lose or change its function.

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 19 – 20

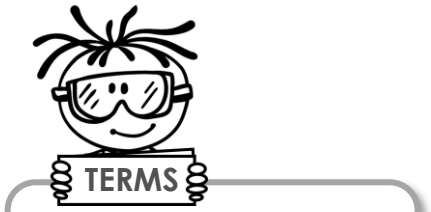
Continue learning

THE ANSWER SERIES Your Key to Exam Success

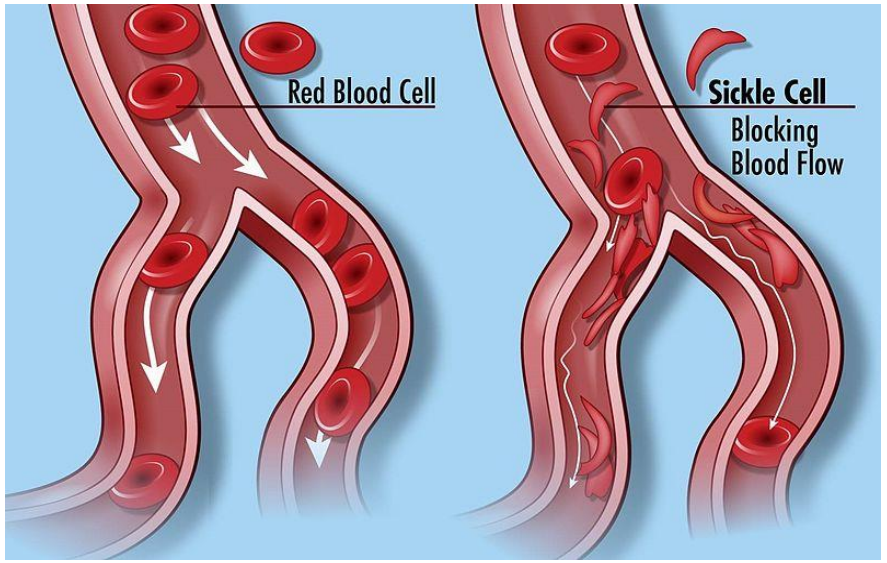
Understanding Mutations – Harmful or Beneficial mutation

Harmful mutations

- ✓ If the change in the protein's structure causes it to lose or change its function, this may be harmful to the organism.
- ✓ Changes in proteins affect processes, e.g.
  - **Haemophilia** is caused by the absence of a blood clotting factor which results in uncontrolled bleeding.
  - **Colour-blindness** is caused by the absence of proteins that form cones for colour vision in the retina of the eye.
  - **Albinism** is caused by the absence of proteins that form melanin in the skin.
  - ***Sickle-cell anaemia*** *is caused by the formation of abnormally-shaped haemoglobin that changes the shape of the red blood cells*. *Enrichment



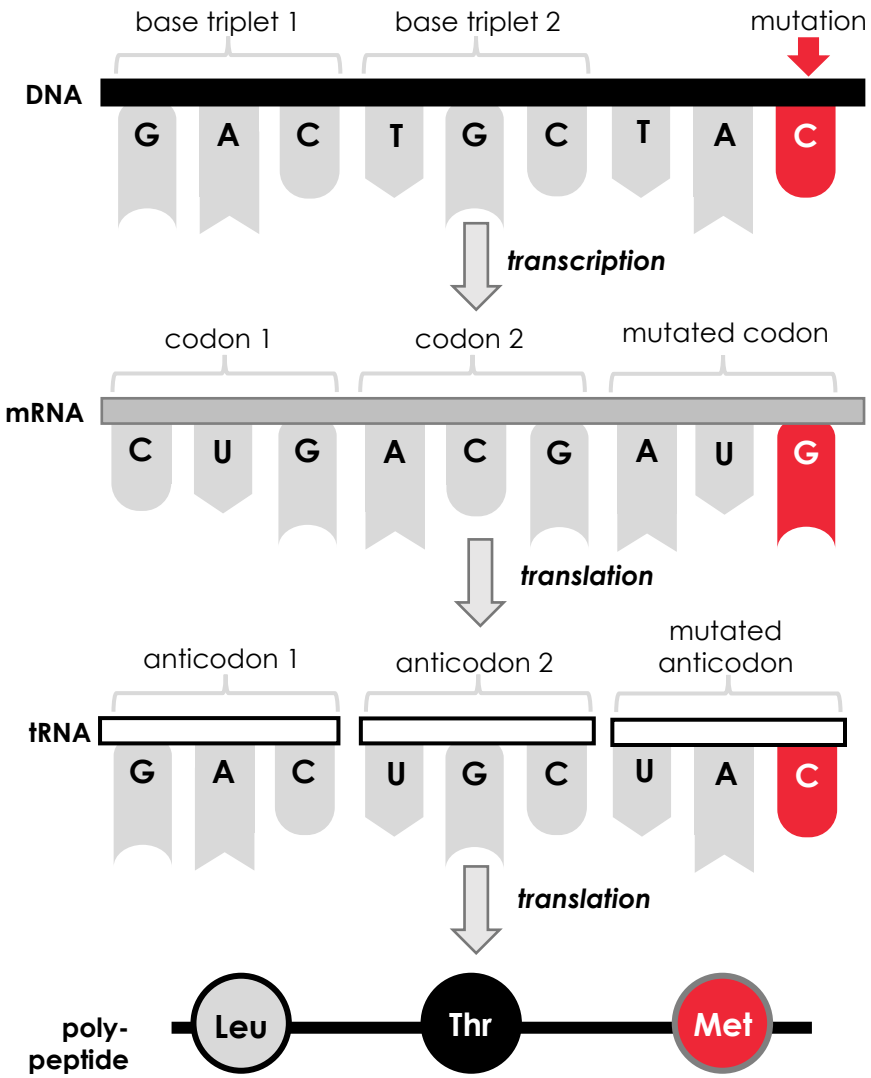
melanin: the pigment that gives colour to the skin, hair and eyes



Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 70, 71 & 61

Continue learning

Mutated DNA strand



Understanding Mutations – Harmful or Beneficial mutation

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Beneficial mutations

- ✓ If the change in the protein's structure causes it to lose or change its function, this may be also be beneficial to the organism.
- ✓ These new alleles may **favour adaptation to a changing environment** and increase an organism's chances of survival.
- ✓ Beneficial mutations **lead to natural selection**, e.g.
  - **Lactose tolerance** is a mutation seen most frequently in populations of the Northern Hemisphere. The mutation maintains the levels of the lactase enzyme (which normally decreases with age in most adults) so that they can easily digest the lactose sugar in milk products. This provides improved access to more proteins, vit D and calcium.
  - Rare cases of **HIV resistance** is beneficial in humans. The mutation changes the surface protein that normally allows HIV to enter the cells. The person is then immune to certain strains of HIV.

NOTE

These mutations are examples of gene mutations. Chromosomal mutations can also be harmful or beneficial, but seldomly harmless.

NOTE

Gene mutations can occur during DNA replication or transcription.

Extract from The Answer Series Grade 12 Life Sciences Part 2 (2024 ed.) p. 69 & 70