



**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

JUNE 2026

LIFE SCIENCES

MARKS: 150

TIME: 2½ hours



This question paper consists of 17 pages.

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start the answer to EACH question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. Do ALL drawings in pencil and label them in blue or black ink.
7. Draw diagrams, tables or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT necessarily drawn to scale.
9. Do NOT use graph paper.
10. You may use a non-programmable calculator, protractor and a compass where necessary.
11. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1.1 to 1.1.10) in the ANSWER BOOK, for example 1.1.11 D.

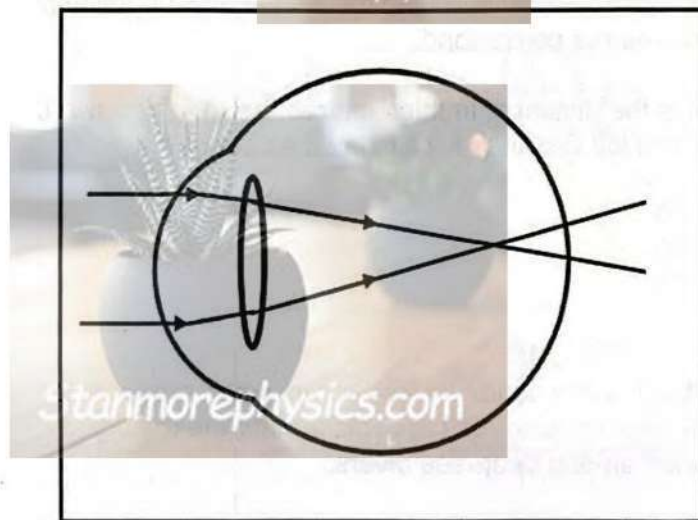
1.1.1 During which stage of meiosis do spindle fibres begin to form?

- A Prophase I
- B Metaphase I
- C Anaphase I
- D Telophase I

1.1.2 Which structures secrete progesterone during pregnancy?

- A Pituitary gland and Graafian follicle
- B Corpus luteum and placenta
- C Endometrium and umbilical cord
- D Chorion and amnion

1.1.3 The diagram below represents a visual defect.



Which ONE of the following is the CORRECT treatment of the visual defect shown above?

- A Glasses with biconvex lenses
- B Glasses with biconcave lenses
- C Surgery to replace the cornea
- D Surgery to replace the retina



1.1.4 Which ONE of the following events occurs in mitosis but NOT in meiosis?

- A Two cells are formed at the end of the division
- B Crossing over takes place
- C Homologous chromosomes arrange at the equator
- D Centrioles form at the poles of the cell

1.1.5 Which part of the eye is rich in blood vessels to provide oxygen and nutrients?

- A Iris
- B Retina
- C Choroid
- D Vitreous humor

1.1.6 Sperm cells in humans are temporarily stored in the ...

- A vas deferens.
- B epididymis.
- C testis.
- D seminal vesicle.



1.1.7 During Anaphase II of meiosis, the two chromatids of a chromosome are pulled apart. Each chromatid moves towards opposite poles at a rate of 2 micrometres per second.

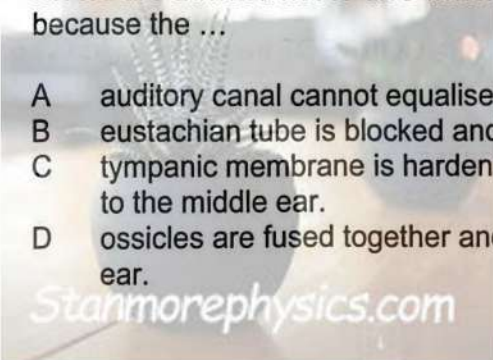
What is the distance, in micrometres, between the two chromatids after 10 seconds? Distance is calculated as speed x time.

- A 20
- B 40
- C 60
- D 80

1.1.8 Barotrauma is a condition that occurs when pressure builds up in the middle ear, causing the tympanic membrane to bulge. It is most common among deep-sea divers.

Divers are advised not to dive when they have a middle-ear infection because the ...

- A auditory canal cannot equalise the pressure in the middle ear.
- B eustachian tube is blocked and air cannot enter the middle ear.
- C tympanic membrane is hardened and cannot pass the vibrations to the middle ear.
- D ossicles are fused together and cannot vibrate freely in the middle ear.



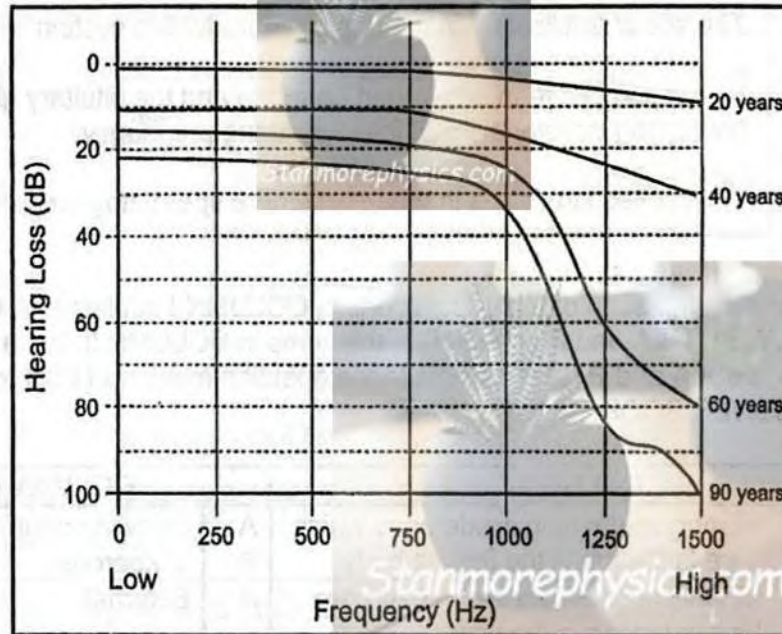
1.1.9 An organism has a diploid number of 16. The total DNA content of the somatic cell is measured as 8 picograms (pg).



Which combination shows the chromosome number and DNA content of the cell after DNA replication, and the chromosome number and DNA content of a gamete formed by meiosis?

	Chromosome number after replication	DNA content of the cell after replication	Chromosome number of gamete	DNA content of gamete
A	16	16	8	4
B	32	16	8	16
C	8	16	16	8
D	16	16	4	8

1.1.10 The diagram below shows the effect of age on hearing ability.



A reasonable conclusion that can be made from this graph is that ...

- A younger people have the same ability to hear all frequencies.
- B as people age they can hear higher frequencies better.
- C 60-year-olds can hear frequencies that younger people cannot hear.
- D older people lose the ability to hear higher frequencies.

(10 x 2) (20)

- 1.2 Give the correct **biological term** for EACH of the following descriptions. Write only the term next to the question numbers (1.2.1 to 1.2.10) in the ANSWER BOOK.

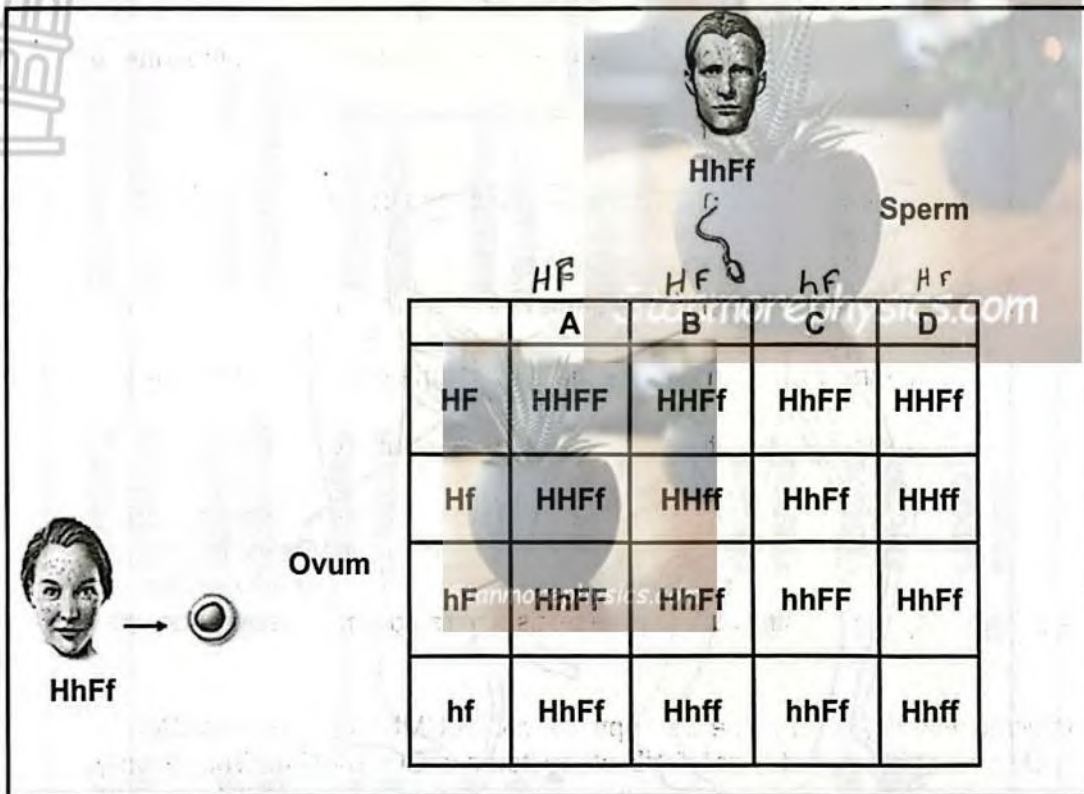
- 1.2.1 The structure that the Graafian follicle develops into after ovulation
- 1.2.2 The hormone that stimulates puberty in females
- 1.2.3 The structure that creates pressure waves in the fluid of the inner ear
- 1.2.4 A receptor in the utricle
- 1.2.5 A progressive brain disorder characterised by memory loss and confusion
- 1.2.6 A hormone that stimulates gamete formation in males
- 1.2.7 Smooth muscles in the eye that adjusts the curvature of the lens
- 1.2.8 The site of fertilisation in the female reproductive system
- 1.2.9 Interaction between an ovarian hormone and the pituitary gland preventing development of follicles during pregnancy
- 1.2.10 Tiny, coiled structures in the testis where spermatogenesis occurs (10 x 1) (10)

- 1.3 Indicate whether each of the descriptions in COLUMN I applies 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 numbers (1.3.1 to 1.3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
1.3.1	Embryos develop inside eggs which are laid outside the female body	A	Ovoviviparous
		B	Viviparous
1.3.2	Fertilisation where semen and ova are released in the water	A	External
		B	Internal
1.3.3	Storage of waste products in the amniotic egg	A	Allantois
		B	Chorion

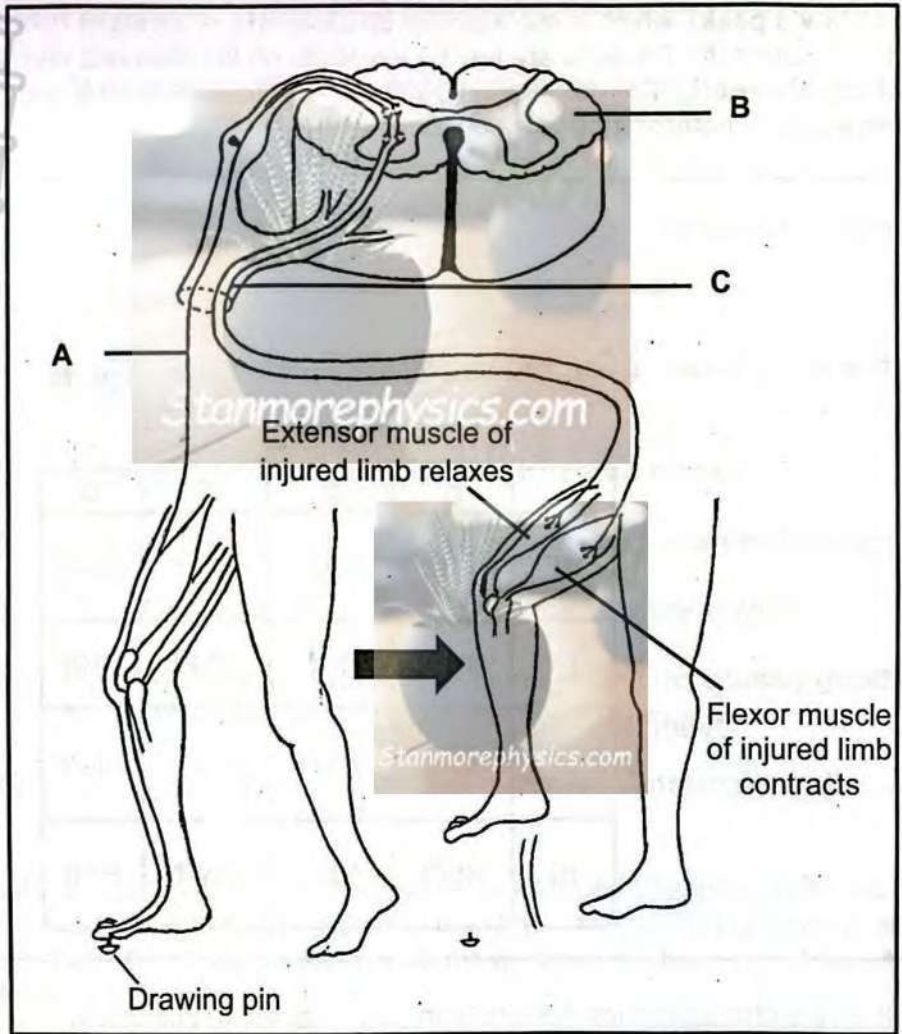
(3 x 2) (6)

1.4 In humans, one gene controls the shape of the hairline and another controls the presence of freckles. The hairline can be curved, forming a point on the forehead (called a **widow's peak**), which is represented by allele (**H**), or **straight** represented by allele (**h**). Freckles are tiny brown spots on the face and can be **present** (**F**) or **absent** (**f**). The diagram below shows a cross between a male and female who are both heterozygous for both genes.



- 1.4.1 State the characteristics that are being investigated in this cross. (2)
- 1.4.2 Determine the genotype of the sperm cells indicated as **A**, **B**, **C** and **D** in the Punnet square. (2)
- 1.4.3 Which process reduced the alleles for the different characteristics in a somatic cell from four to two in each gamete? (1)
- 1.4.4 Name the process in reproduction indicated by the Punnett square. (1)
- 1.4.5 Give the percentage of offspring which have a widow's peak hairline, but no freckles. (1)

1.5 The diagram below represents a reflex action.



1.5.1 Give the LETTER and NAME of the part that:

- (a) Transmits an impulse to the spinal cord (2)
- (b) Represents a peripheral nervous system (2)

1.5.2 Name the effectors that were involved in this reflex arc. (2)

1.5.3 How many neurons transmitted the impulse from the spinal cord to the effectors? (1)

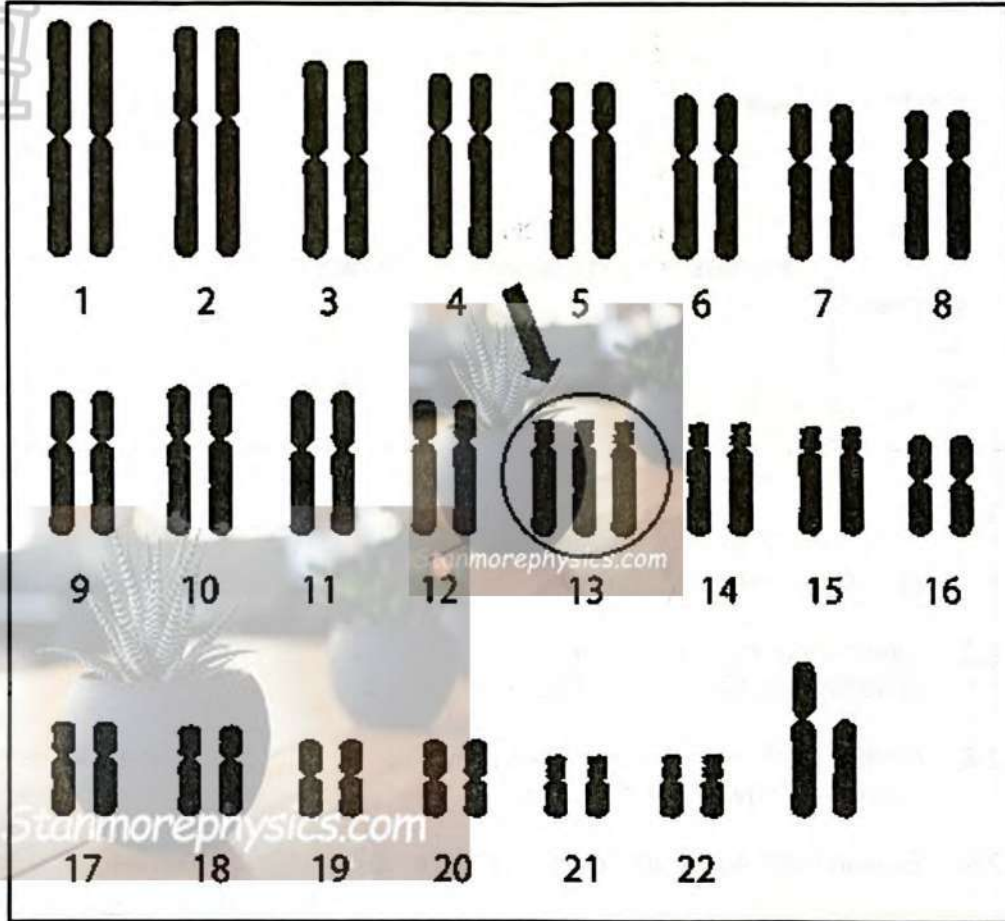
[50]

TOTAL SECTION A: 50

SECTION B

QUESTION 2

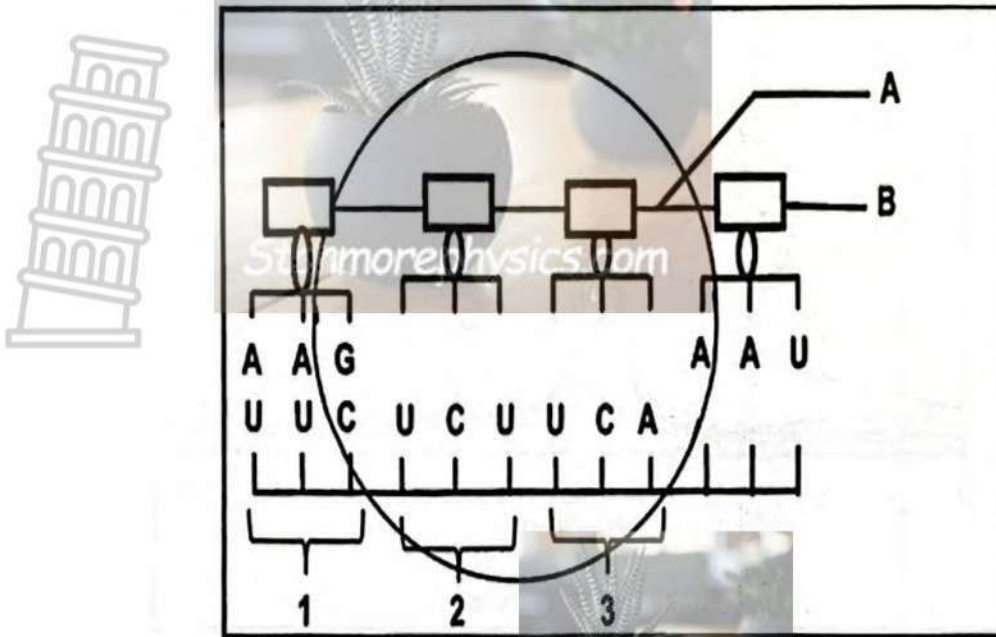
2.1 The diagram below represents a karyotype of a child with Patau syndrome. Some of the Patau syndrome symptoms include slow breathing, heart defects and kidney malfunctioning.



- 2.1.1 How many autosomes are represented in this karyotype? (1)
- 2.1.2 State why the karyotype shown represents a somatic cell. (1)
- 2.1.3 Name the error in meiosis that resulted in the abnormal number of chromosomes at position 13. (1)
- 2.1.4 State the phase of meiosis in which the error mentioned in QUESTION 2.1.3 occurs. (1)
- 2.1.5 Describe the abnormal gamete involved in fertilisation that produced a child with Patau syndrome. (2)
- 2.1.6 Explain how the karyotype of a boy with Down syndrome is different to that of a boy with Patau syndrome. (4)

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2.4 The diagram below shows a stage in protein synthesis.



The table below shows the tRNA molecules that code for different amino acids.

ACU ACC ACA ACG	Threonine	AAU AAC	Asparagine	AGU AGC	Serine
		AAA AAG	Lysine	AGA AGG	Arginine

2.4.1 Identify:

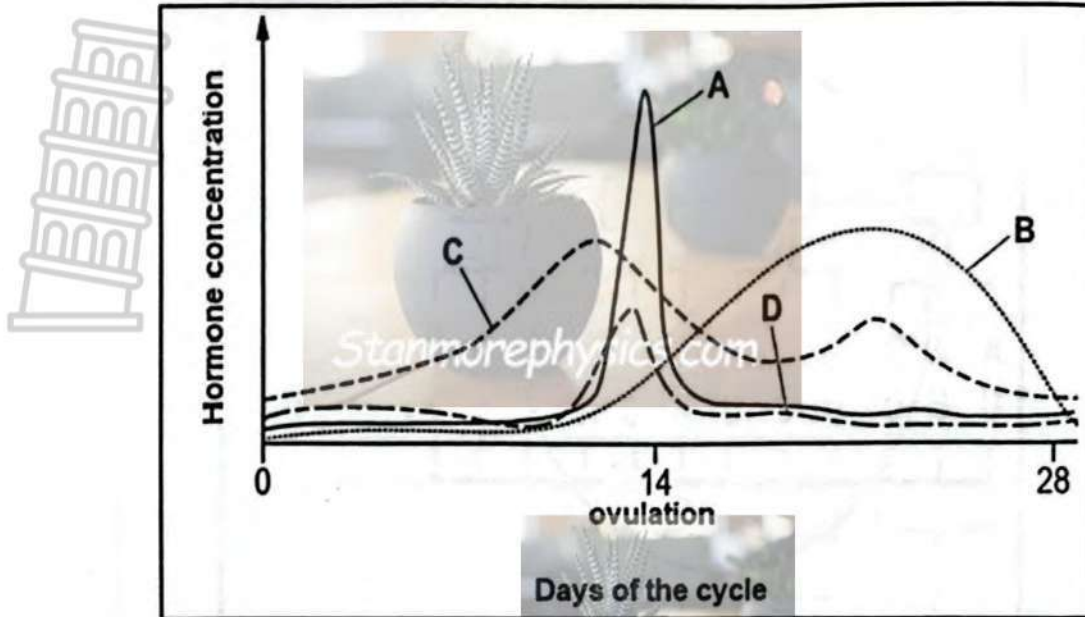
- (a) Bond A (1)
- (b) Molecule B (1)

2.4.2 Write down the mRNA codon that codes for asparagine in the diagram. (1)

2.4.3 In codon 3, guanine was replaced by cytosine as a result of a mutation.

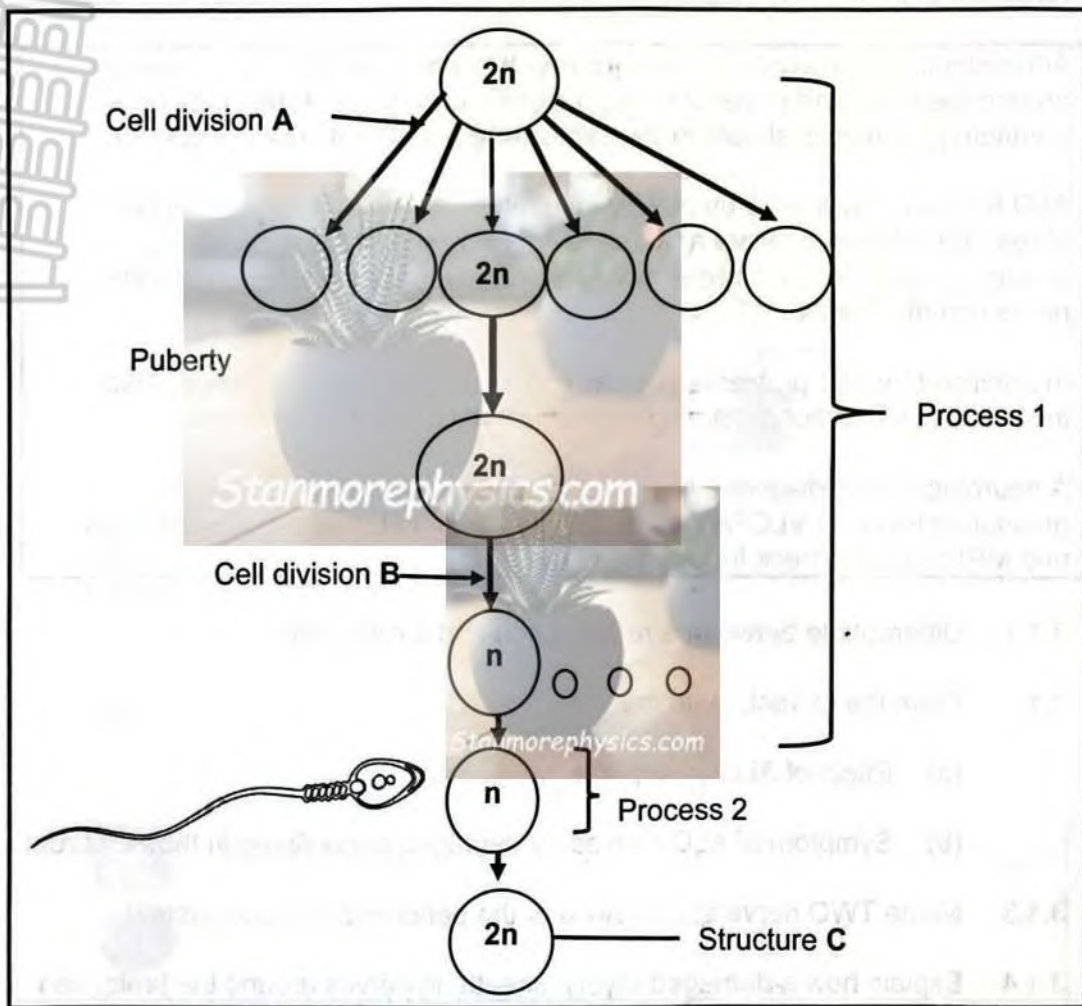
Explain how this will affect the protein that will be formed. (4)

2.5 The diagram below represents the hormonal control of the menstrual cycle.



- 2.5.1 Provide the LETTER and NAME of the hormone that:
- Stimulates the development of the Graafian follicle (2)
 - Stimulates the Graafian follicle to release a mature ovum (2)
- 2.5.2 On which day of the cycle did ovulation occur? (1)
- 2.5.3 Explain your answer to QUESTION 2.5.2. (2)
- 2.5.4 Explain the effect of the negative feedback mechanism between hormones B and C if fertilisation occurs. (4)

2.6 The diagram below shows two processes occurring in the female reproductive system.



2.6.1 Identify:

- (a) Cell division A (1)
- (b) Cell division B (1)
- (c) Process 1 (1)
- (d) Process 2 (1)

2.6.2 Identify the organ in which process 1 occurs. (1)

2.6.3 Describe the development of structure C until the formation of the placenta. (5)

[50]

QUESTION 3

3.1 Read the extract below.

Adrenoleukodystrophy (ALD) is a disorder that damages the nerve insulation around the brain and spinal cord. ALD significantly affects reflex arcs by damaging the myelin sheath in the central and peripheral nervous system.

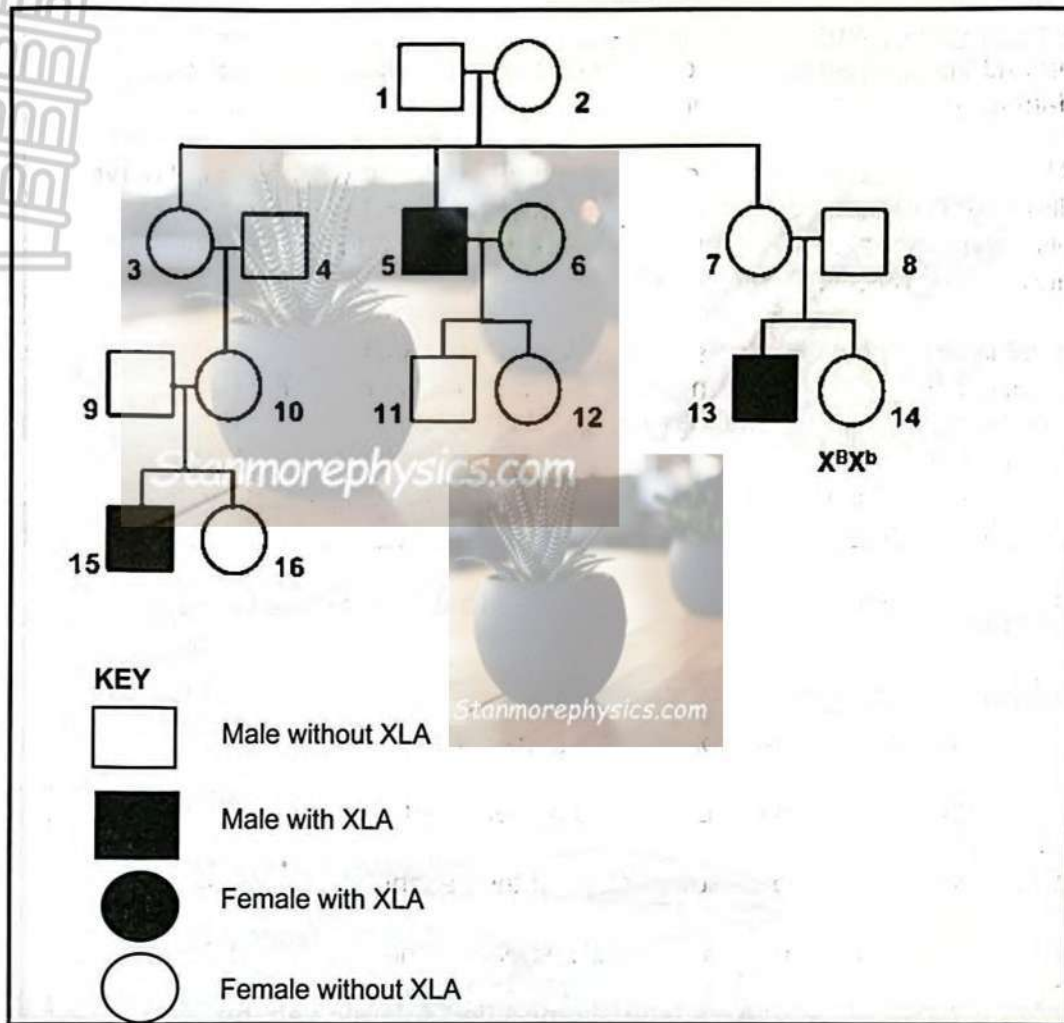
ALD is caused by a build-up of very long fatty acids (VLCFAs) around nerve fibres. VLCFAs accumulate and destroy myelin around the nerve fibres, disrupting nerve impulse transmission which may lead to slower or blocked nerve communication.

In addition to motor problems such as loss of coordination symptoms, also include loss of memory, learning difficulties, vision- and hearing loss.

A neurologist may diagnose ALD through a combination of blood tests measuring levels of VLCFAs, often followed by genetic testing for mutations and MRI scans to check for brain damage.

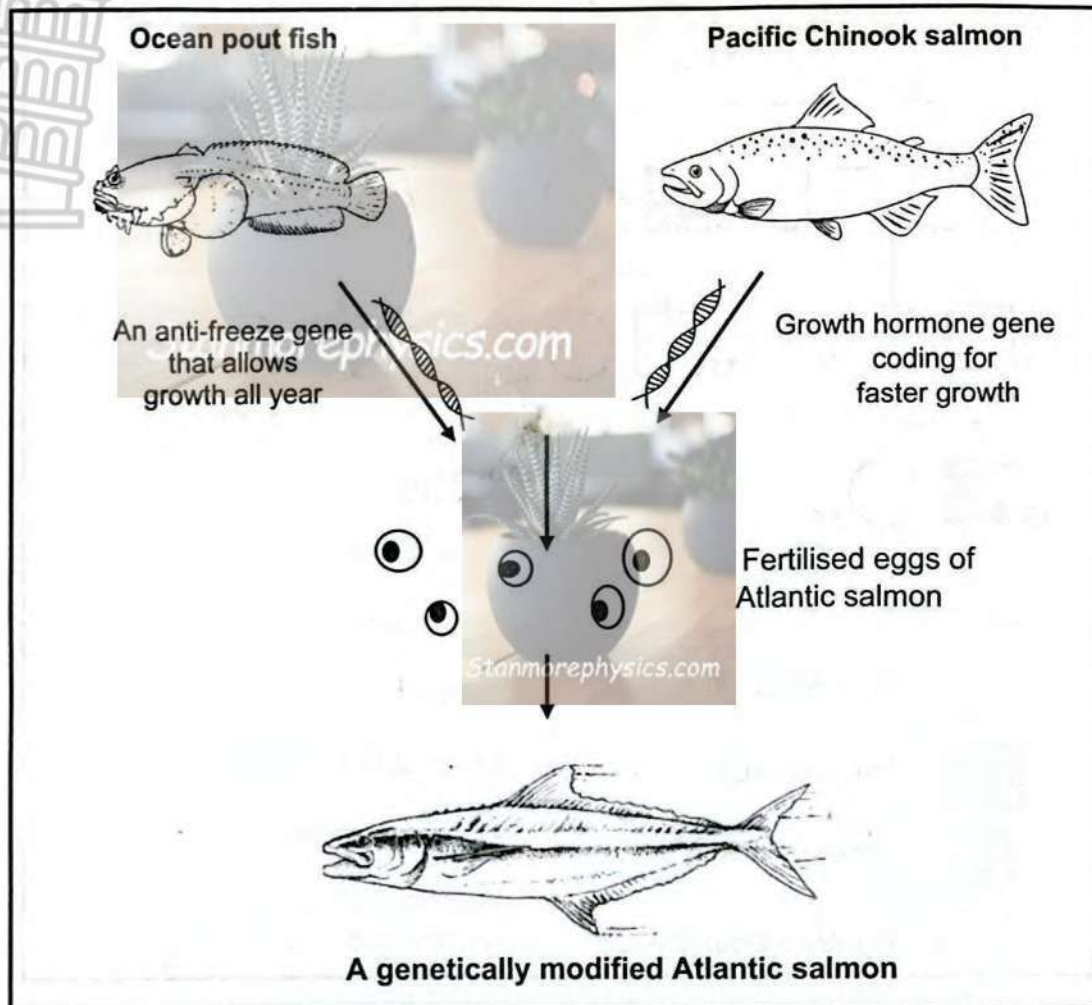
- 3.1.1 Differentiate between a *reflex action* and a *reflex arc*. (2)
- 3.1.2 From the extract, state the:
- (a) Effect of ALD on impulse transmission (1)
 - (b) Symptom of ALD caused by damaged nerve fibres in the cerebrum (1)
- 3.1.3 Name TWO nerve subdivisions of the peripheral nervous system. (2)
- 3.1.4 Explain how a damaged myelin sheath, in nerves around the brain, can lead to a loss of coordinating voluntary movement. (3)

3.2 XLA syndrome is a rare sex linked inherited immune deficiency caused by a mutation in the BTK gene, leading to a lack of antibody production and recurrent bacterial infection.



- 3.2.1 What is the main use of a pedigree diagram? (1)
- 3.2.2 Define a *sex-linked inheritance*. (1)
- 3.2.3 Explain why XLA is not caused by a dominant allele. (2)
- 3.2.4 Give ALL the NUMBER(s) representing:
 - (a) Male(s) without XLA in the F² generation (1)
 - (b) Individuals which are not related to 1 and 2 (2)
- 3.2.5 Use a genetic cross to show the percentage chance of the next child born from individuals 13 and 14 ($X^B X^b$) suffering from XLA syndrome. (6)
- 3.2.6 Explain why it is less common for girls to suffer from XLA syndrome compared to boys. (4)

- 3.3 A biotechnological process was done on the eggs of Atlantic Salmon, producing a fish that grows fast to a very large size and capable of growth all year round instead of growing only in spring and summer. The diagram below shows steps of the biotechnological process.



- 3.3.1 Define *biotechnology*. (1)
- 3.3.2 Differentiate between *cloning* and *genetic engineering*. (4)
- 3.3.3 Describe how a genetically engineered Atlantic salmon is produced. (6)

3.4 The macula is a small area in the retina that contains many cone cells. It helps people to read, recognise faces and drive. Age-related Macular Degeneration (AMD) damages the macula, which makes reading and recognising faces difficult.

Scientists conducted an investigation to find out whether a **retinal implant** (a very small medical device) could help restore vision in people with advanced AMD.

The procedure was as follows:

- 38 participants, with an average age of 79 years, from five European countries took part in the study. All participants had advanced AMD.
- A microscopic retinal implant was surgically placed under the retina at 17 hospitals across the five countries.
- The participants' ability to read letters and recognise objects was tested before and after the procedure.
- Vision tests were done 12 months later by independent testers who did not know which patients had received the implant.

The results of the investigation are as follows:

- 32 participants completed the 12-month follow-up.
- 84% of these participants showed a clear improvement in reading words and recognising objects.
- Three participants died from causes not related to the implant, one withdrew from the study, and two were unavailable for testing.

3.4.1 State the:

- (a) Independent variable (1)
- (b) Dependent variable (1)

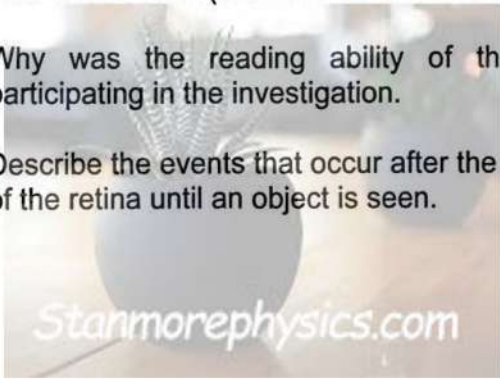
3.4.2 Explain why all participants had to sign a declaration of consent before participating in this clinical trial. (2)

3.4.3 How many participants showed an improvement in reading ability? Show ALL calculations (round off to the nearest whole number). (3)

3.4.4 Why was the reading ability of the participants assessed before participating in the investigation. (2)

3.4.5 Describe the events that occur after the light rays focus on the yellow spot of the retina until an object is seen. (4)

[50]



TOTAL SECTION B: 100
GRAND TOTAL: 150



NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2026

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LIFE SCIENCES
AMENDED MARKING GUIDELINE

MARKS: 150 Stanmorephysics.com

TIME : 2,5 hrs

PRINCIPLES RELATED TO MARKING LIFE SCIENCES

- 1. If more information than marks allocated is given**
Stop marking when maximum marks is reached and put a wavy line and 'max.' in the right-hand margin.
- 2. If, for example, three reasons are required and five are given**
Mark the first three irrespective of whether all or some are correct/incorrect.
- 3. If whole process is given when only a part of it is required**
Read all and credit the relevant part.
- 4. If comparisons are asked for but descriptions are given**
Accept if the differences/similarities are clear.
- 5. If tabulation is required but paragraphs are given**
Candidates will lose marks for not tabulating.
- 6. If diagrams are given with annotations when descriptions are required**
Candidates will lose marks.
- 7. If flow charts are given instead of descriptions**
Candidates will lose marks.
- 8. If sequence is muddled and links do not make sense**
Where sequence and links are correct, credit. Where sequence and links are incorrect, do not credit. If sequence and links become correct again, resume credit.
- 9. Non-recognised abbreviations**
Accept if first defined in answer. If not defined, do not credit the unrecognised abbreviation but credit the rest of the answer if correct.
- 10. Wrong numbering**
If answer fits into the correct sequence of questions but the wrong number is given, it is acceptable.
- 11. If language used changes the intended meaning**
Do not accept.
- 12. Spelling errors**
If recognisable, accept the answer, provided it does not mean something else in Life Sciences or if it is out of context.
- 13. If common names are given in terminology**
Accept, provided it was accepted at the national memo discussion meeting.
- 14. If only the letter is asked for but only the name is given (and vice versa)**
Do not credit.

15. **If units are not given in measurements**

Candidates will lose marks. Marking guideline will allocate marks for units separately.

16. **Be sensitive to the sense of an answer, which may be stated in a different way.**

17. **Caption**

All illustrations (diagrams, graphs, tables, etc.) must have a caption.

18. **Code-switching of official languages (terms and concepts)**

A single word or two that appear(s) in any official language other than the learners' assessment language used to the greatest extent in his/her answers should be credited if it is correct. A marker that is proficient in the relevant official language should be consulted. This is applicable to all official languages.



SECTION A

QUESTION 1

- 1.1 1.1.1 A✓✓
 - 1.1.2 B✓✓
 - 1.1.3 A/B✓✓
 - 1.1.4 A✓✓
 - 1.1.5 C✓✓
 - 1.1.6 B ✓✓
 - 1.1.7 B ✓✓
 - 1.1.8 B✓✓
 - 1.1.9 A✓✓
 - 1.1.10 D✓✓
- (10 x 2) (20)

- 1.2 1.2.1 Corpus luteum ✓
 - 1.2.2 Oestrogen ✓
 - 1.2.3 Oval window ✓ fenestra ovalis
 - 1.2.4 Macula✓
 - 1.2.5 Alzheimer✓
 - 1.2.6 Testosterone✓/FSH
 - 1.2.7 Ciliary muscle✓
 - 1.2.8 Fallopian tube✓
 - 1.2.9 Negative feedback✓
 - 1.2.10 Seminiferous tubules✓
- (10 x 1) (10)

- 1.3 1.3.1 None✓✓
 - 1.3.2 A only✓✓
 - 1.3.3 A only✓✓
- (3 x 2) (6)

- 1.4 1.4.1 Presence /absence of freckles✓ and shape of the hairline✓ (2)
 - 1.4.2 HF,Hf,hF,Hf✓✓/ HF,Hf,hF,hf (2)
 - 1.4.3 Meiosis✓ (1)
 - 1.4.4 Fertilisation✓ (1)
 - 1.4.5 25%✓/18.75% / 19% (1)
- (7)

- 1.5 1.5.1 a) A✓ sensory neuron✓ (2)
- b) C✓ spinal nerve ✓/ Motor neuron
- OR**
- A ✓sensory neuron✓ (2)
- 1.5.2 Extensor muscle✓ and flexor muscle ✓ (1)
- 1.5.3 Two✓ (2)

TOTAL SECTION A: (11) 50

QUESTION 2

- 2.1 2.1.1 45✓ (1)
- 2.1.2 Homologous chromosomes are shown✓/ chromosomes are in pairs / **diploid number/ Full set of chromosomes/ has both paternal and maternal sets of chromosomes** (1)
- 2.1.3 Non disjunction✓ (1)
- 2.1.4 Anaphase I✓/II (1)
- 2.1.5 - The gamete has 24 chromosomes✓.
- At position 13 there are two chromosomes instead of one✓ (2)
- 2.1.6 - **In Patau syndrome there are 3 chromosomes in pair 13✓ instead of two ✓**
- **In down Syndrome there are 3 chromosomes in pair 21✓ instead of two✓** (4)
- 2.2 2.2.1 (a) Suspect 2✓ (1)
- (b) - All the DNA bars of suspect 2 match the DNA bands of the sample from the nails✓/ DNA bands of suspect 2 are a 100%/exact match to those found in the nail sample.
- **All 13 DNA bands of suspect 2 match those of the sample from the nails✓** Any 1 (1)
- 2.2.2 - All the DNA bars of the victim do not match with those found on the nail sample ✓
- showing that the sample belongs to another person as the DNA of all individuals are unique✓
- OR**
- If the victim had scratched herself, only her own DNA would be present under her nails. ✓
- The DNA found under the nails does not match the victim's DNA but matches that of Suspect 2. ✓ (2)
- 2.2.3 - **DNA samples could be planted on crime scene✓ resulting in conviction of innocent people✓**
- **Human error when analysing the DNA profile✓ could lead to wrong arrests✓**



- **Twins share identical DNA** ✓,
- a wrong twin can be arrested for what he/she did not do** ✓
- **A short segment of DNA is used** ✓
- therefore, results may not be reliable** ✓
- **Swapping samples in lab** ✓
- could lead to false accusation** ✓
- **DNA profile cannot determine the time when the DNA tissue was left on the victim's nails** ✓
- therefore, it cannot determine the time of contact** ✓

(Mark first TWO only)

(Any 1 X 2) (2)

- 2.2.4
- High level of accuracy ✓ as every persons DNA is unique ✓
 - **DNA is unique to individuals who are not identical twins** ✓ **and is accurately used to identify suspects** ✓ **can be used to save innocent accused individuals**
 - **Criminals whose DNA profiles are in the police database** ✓ **are quickly caught when they commit crimes** ✓

(Any 1 X 2) (2)

(8)

- 2.3
- Both occur in the nucleus ✓ / nucleoplasm
 - Both involve unwinding (unzipping) of the DNA double helix ✓
 - Both involve unzipping of DNA double helix/ breaking of hydrogen bonds
 - Both involve separation of the two DNA stands ✓
 - **Both use DNA template** ✓
 - **Both use free nucleotides from the nucleoplasm** ✓
 - **Both process are controlled by enzymes** ✓
 - **Both involve complementary bases** ✓

(Any 4) (4)

- 2.4 2.4.1 (a) Peptide bond ✓ (1)
- (b) Amino Acid ✓ / asparagine (1)
- 2.4.2 UUA ✓ (1)
- 2.4.3
- **Codon is UCA instead of UGA** ✓
 - **Anticodon is AGU instead of ACU** ✓
 - **amino acid would be serine** ✓ **instead of threonine** ✓
 - Sequence of amino acids will change ✓

- A different protein will be formed ✓ (Any 4) (4)

(7)

2.5 2.5.1 (a) **D** ✓ - Follicle stimulating hormone ✓ (FSH) (2)

(b) **A** ✓ - Luteinising hormone ✓ (LH) (2)

2.5.2 Day 14 ✓ / 13 (1)

2.5.3 - **LH** / Luteinizing hormone is at its peak ✓,
- stimulating the Graafian follicle to burst ✓ (2)

2.5.4 - **Corpus luteum continues secreting progesterone ✓ / hormone B**

- **This results in high level of progesterone in the blood ✓**

- **This inhibits the secretion of FSH ✓**

- **by the pituitary gland ✓**

- **As a result, no follicle develops ✓**

- **and no oestrogen is secreted ✓**

(Any 4) (4)

(11)

2.6 2.6.1 (a) Mitosis ✓ (1)

(b) Meiosis ✓ (1)

(c) oogenesis ✓ (1)

(d) fertilisation ✓ (1)

2.6.2 Ovary ✓ (1)

2.6.3 - Zygote divides by mitosis ✓

- **to form a solid ball of cells ✓**

- called the morula ✓

- The morula divides by mitosis **to form a hollow ball of cells ✓**

- called the blastula ✓

- The chorion forms the finger like projections the chorionic villi ✓

- These chorionic villi and the endometrium form the placenta ✓

(Any 5) (5)

(10)

QUESTION 3

- 3.1 3.1.1 - Reflex action is a rapid involuntary response to a stimulus✓ (2)
- Reflex arc is the pathway followed by an impulse from the receptor to the effector✓ (2)
- 3.1.2 (a) slows impulse ✓ transmission (1)
- (b) Loss of memory/learning difficulties/vision and hearing loss✓ (1)
- 3.1.3 - **Autonomic nerves**✓
- **Somatic nerves**✓ (Remove this is not in the examination guidelines) (2)
- 3.1.4 A damaged myelin sheath leads to:
- slower /blocked impulse transmission✓
 - from the cerebellum✓
 - to the skeletal muscles✓.
 - Skeletal muscle contraction and relaxation will be disrupted leading
 - to impaired movement✓
 - **resulting in loss of balance/equilibrium** ✓
- (Any 3) (3)
- (9)**

CONVERSION TABLE (CT) For Question 3.1.3	
Learner mark out of 8	Add
1-5	0
6-8	1

- 3.2 3.2.1 To trace an inheritance of a genetic disorder/ characteristic over generations✓ /families
- OR
- to trace how traits are passed down through generations/ families (1)
- 3.2.2 Inheritance caused by an allele carried on the X chromosomes✓/sex-chromosomes / **gonosomes** (1)
- 3.2.3 - Individual 14 is a female without XLA✓
- Her genotype is $X^B X^b$ ✓/She has a dominant allele that masks the recessive allele X^b / If XLA were caused by a dominant allele, she would show the condition.

OR

XLA cannot be caused by a dominant allele because unaffected parents (e.g. 1 and 2) have an affected child (5)✓. If the allele were dominant, mother (2) would have shown the condition.✓



OR

Similarly, individuals 7 and 8 do not have XLA, but they have an affected son, 13. ✓ If the allele were dominant, mother (7) would have shown the condition.✓

OR

Individuals 9 and 10 do not have XLA, but they have an affected son, 15. ✓ If the allele were dominant, mother (10) would have shown the condition.✓

OR

XLA is not caused by a dominant allele because affected male 5 has an unaffected daughter✓ (12). If the allele were X-linked dominant, all daughters of an affected father would inherit the dominant allele and be affected. ✓

(2)

(Any 1 x 2)

3.2.4 (a) 9,11✓

(1)

(b) 4,6,8✓✓

(2)

3.2.5 P1: phenotype Male with XLA X Female without XLA✓

Genotype: X^bY X X^BX^b ✓

Meiosis:

Gametes:



Fertilisation:

F1 genotype: X^BX^b X^bX^b X^BY X^bY ✓

Phenotype 1 female without XLA; 1 female with XLA; 1 male without XLA; 1 male with XLA ✓

50% ✓* chance of a child with XLA

OR



P1: phenotype Male with XLA X Female without XLA ✓

Genotype: X^bY X $X^B X^b$

Meiosis:

Gametes	X^B	X^b
X^b	$X^B X^b$	$X^b X^b$
Y	$X^B Y$	$X^b Y$

Fertilisation ✓

F1 genotype: $X^B X^b$ $X^b X^b$ $X^B Y$ $X^b Y$ ✓

Phenotype 1 female without XLA; 1 female with XLA;
1 male without XLA; 1 male with XLA
50% ✓* chance of a child with XLA

P1 & F1 ✓

Meiosis & fertilisation ✓ *1 compulsory mark + any 5

(6)

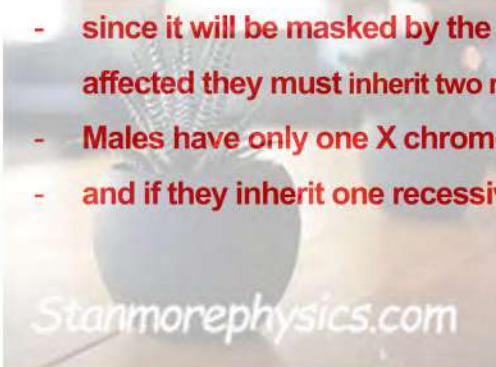
We acknowledge that question 3.2.5 may be viewed as having overstepped an ethical boundary. While this is an ethical concern, it does not affect the correctness of the expected responses and therefore does NOT require any amendment to the Marking Guideline. We apologise for this oversight and will take greater care to ensure that future assessments are appropriately framed.

- 3.2.6
- XLA syndrome is caused by a recessive allele ✓
 - found in X chromosome ✓
 - Females have only two X chromosomes ✓
 - If they inherit one recessive allele, they will not have XLA syndrome ✓
 - since it will be masked by the dominant allele ✓ / for them to be affected they must inherit two recessive alleles
 - Males have only one X chromosomes ✓
 - and if they inherit one recessive allele, they have the XLA syndrome ✓

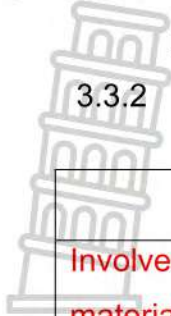
(Any 4)

(4)

(17)



3.3 3.3.1 A process where biological processes are manipulated to satisfy human needs✓ (1)

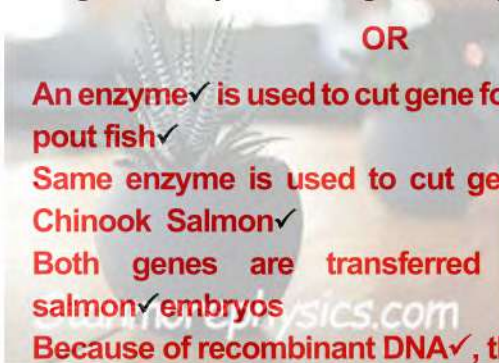


3.3.2

Cloning	Genetic engineering
Involves insertion of all the genetic material of donor organism✓	Only the gene for desirable characteristic is inserted✓
Genetic material is inserted in the ovum✓	Genetic material is inserted into the DNA molecule✓/ chromosomes
- results in production of genetically identical organisms✓	- results in genetically modified Organisms/GMOs✓
- Leads to no variation ✓	- leads to variation amongst organisms✓
- No new trait✓	- A new trait✓/phenotype is produced
- Same species used✓	- Same or different species used✓

(Any 2 X 2) (4)

- 3.3.3 - An antifreeze gene from the ocean pout fish✓
 - and a growth hormone gene from the chinook salmon✓
 - are inserted into the nucleus✓
 - of fertilised eggs of salmon fish✓
 - The eggs then develop into a genetically engineered Atlantic salmon✓
 - that grows very fast and grows all year round✓



- OR**
- An enzyme✓ is used to cut gene for all year round growth from ocean pout fish✓
 - Same enzyme is used to cut gene for faster growth from Pacific Chinook Salmon✓
 - Both genes are transferred to the DNA of an Atlantic salmon✓embryos
 - Because of recombinant DNA✓, the salmons grow all year faster✓

(6)
(11)

- 3.4 3.4.1 (a) retinal implant✓/(presence or absence of) implanted device (1)
- (b) vision✓ (1)



- 3.4.2 - To ensure that participants voluntarily agreed to take part in the study✓
- To confirm that participants were fully informed about the procedure, risks and benefits ✓
- To provide a legal record for the participant and research team/protests researchers from legal obligations ✓/**Investigators have to protect themselves from people who might sue for damages✓/ avoid accountability for damage**

(Any 2) (2)

3.4.3 $\frac{84}{100} \checkmark \times 32 \checkmark = 27 \checkmark$ participants (3)

- 3.4.4 - To provide the baseline✓ (original) reading ability of the participants.
- to allow a fair comparison between vision before and after the retinal implant✓

OR

- **To get initial vision ✓/ baseline**
- **so that it is established whether the implants helped to restore vision of people with AMD or not ✓**

(2)

- 3.4.5 - Photoreceptors (cones) in the yellow spot are stimulated✓
- light stimulus changed/converted into an impulse✓
- Impulses is transmitted by the optic nerve✓
- To the cerebrum✓ for the interpretation of the image✓

Any (4)

(13)

[50]

TOTAL SECTION B: 100

GRAND TOTAL: 150