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**MID-YEAR EXAMINATION: PAPER 1 (2023)****SUBJECT: Life Science****Grade 12**

EXAMINER:	J. J. Hanneman	MARKS:	120
MODERATOR:	C. van de Venter (Durban Girls College)	TIME:	120 minutes

NAME & CLASS:

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. This question paper consists of 21 pages and 3 questions. Make sure your paper is complete.
 2. Answer ALL the questions on your question paper.
 3. Calculators may be used.
 4. The use of Tipp-Ex is NOT permitted.
 5. It is in your own interest to write legibly and to present your work neatly.
-

Question	Mark awarded	Mark allocation	Total
1		40	
2		40	
3		40	
			/120

QUESTION 1

1.1 Select the term in column B that best matches the description in column A. Write the letter of the term in the space provided in between the brackets. Each letter may only be used once.

COLUMN A	COLUMN B
[] Type of inheritance where one allele is expressed in the body (phenotype).	A: Chiasma
[] All the genes that make up an individual.	B: Franklin and Wilkins
[] Awarded the Nobel Prize for working out the structure of DNA.	C: Spindle fibres
[] Affects the movement of chromosomes during cell division.	D: Karyotypes
[] Chromosomes cross over at these points.	E: Plasmid
[] Different forms of the same gene	F: Alleles
[] A condition in which more than two sets of chromosomes are present in a cell.	G: Watson and Crick
[] A 'ring' of DNA found in bacteria and useful in genetic engineering.	H: Polyploidy
[] Process in which DNA makes a copy of itself.	I: Replication
[] A picture of chromosomes arranged in homologous pairs, to see chromosomal abnormalities.	J: Genome
	K: Diploid
	L: Dominance
	M: Recessive

(10)

1.2 State whether each of the following statements are “True” or “False”. If the given statement is false, state which word you would change to correct the statement. Indicate what word you would replace the incorrect word with.

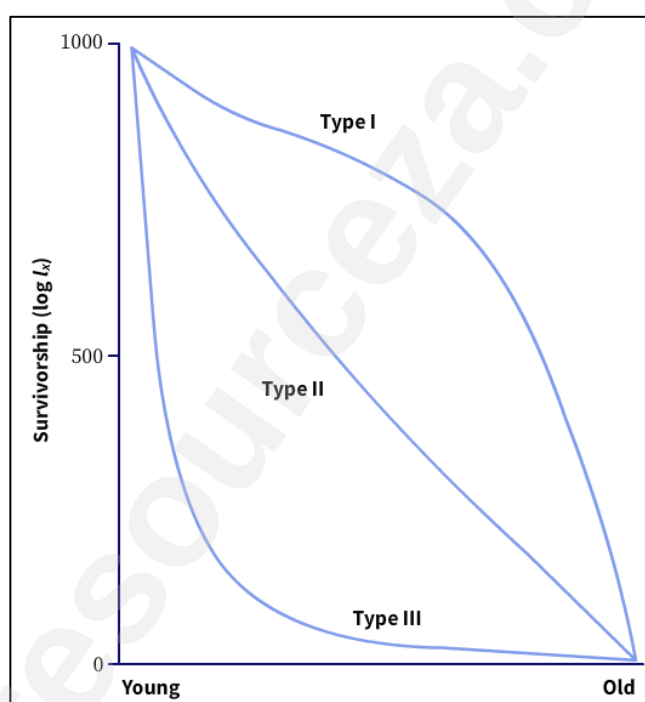
	Statement	True/False	Word to be replaced and correct word
1.2.1	Asexual reproduction allows plants to adapt to environmental changes.		
1.2.2	Hybridisation of plants increases levels of disease resistance.		
1.2.3	Plant breeders regularly remove the petals of plants to prevent cross pollination.		
1.2.4	Micropropagation is the insertion of the top of plant and inserting it into the rootstock of another plant.		
1.2.5	Mutation breeding is the process of intentional creating genetic variation in crop plants.		

(10)

- 1.3 Use the table and figure below to answer the following questions. The table shows the number of organisms counted in neighbouring ecosystems over a period two months.

Fish		Elephants	
Hatchlings	11 860	Calves	2
Juveniles	248	Juveniles	2
Adults	117	Adults	1

Figure 1.1: Survivorship curves of differing reproductive strategies



- 1.3.1 Which line of the diagram, (type I, type II or type III) best describes the reproductive strategy of fish?

(1)

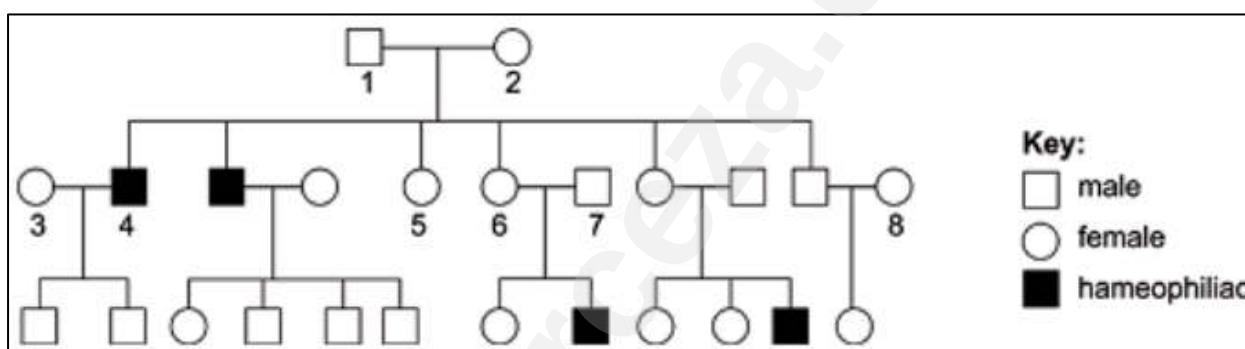
- 1.3.2 Describe how the difference in reproductive strategies between fish and elephants results in different survivorship curves.

(4)

- 1.4 Haemophilia A is a genetic disorder caused by a mutation in the gene coding for a blood-clotting factor known as Factor VII. The mutation is located on the X-chromosome. Factor VII is a type of protein that is absent in the blood plasma of people with Haemophilia A.

Study the family pedigree below and answer the questions that follow:

Figure 1.2: Family pedigree showing the inheritance of haemophilia



- 1.4.1 Explain why haemophilia cannot be considered an autosomal characteristic? (2)

- 1.4.2 Complete the table below to show the genotypes of certain family members. (3)

Number of individual	Genotype
8	$X^H X^H$
4	
6	
7	

- 1.4.3 By means of a genetic diagram, show how individuals 1 and 2, neither of whom are haemophiliacs, have had two sons who are haemophiliacs. Include the following in your answer:
- Parental genotypes and phenotypes
 - A Punnet diagram
 - Ratios of possible phenotypes and genotypes of the offspring.

(6)

- 1.5 Read the extract from a study in genetic medicine before answering the questions that follow.

Gene Mutation May Explain Brain Cell Plaque Build-up in Alzheimer's Disease

A mutation in the gene that plays a key role in the brain's immune defences may prevent cells from clearing away protein-filled clumps. The build-up of these clumps (also known as plaque) sets off an immune response that can kill brain cells – potentially resulting in dementia. During studies conducted on mice, it was found that the gene affected, *inositol polyphosphate-5-phosphatase D* (INPPD5), underwent a frameshift mutation.

[Source: <https://nyulangone.org/news/gene-mutation-may-explain-brain-cell-plaque-build-up-alzheimers-disease>]

- 1.5.1 Name two types of point mutations that would result in an altered reading frame.

(2)

,

- 1.5.2 Explain how a frameshift mutation might result in an altered gene product.

(2)

[40 MARKS]

QUESTION 2

- 2.1 Use the information below and your own knowledge to answer the questions that follow.

Scientists have found a way to genetically engineer the goodness of fish oil in a widely used plant oil.

Fish oil became a popular supplement after its ingredients, especially omega-3 fatty acids, were linked to benefits such as improved heart health and nervous system function. This knowledge set off the rapid increase of fish consumption across the world. We now consume twice as much fish per capita as we did in the 1960s.

Scientists have been trying to find vegetarian, conservation-minded ways of fulfilling our demand for omega-3 fatty acids, without having to rely on fish. According to a new study published in [*Nature Biotechnology*](#), researchers at Dow AgroSciences have found one such alternative. They have genetically engineered canola, a type of rapeseed oil, to produce additional omega-3 fatty acids.

Researchers at Dow took the omega-3 fatty acid gene of a microalgae, a type of plankton, and added it to a canola plant. The resulting transgenic seeds contained as much as 200 milligrams of omega-3 fatty acids in a single tablespoon of oil. Previous efforts at enabling plants to produce omega-3 fatty acids have been successful, but they have not been able to produce commercially viable amounts.

Source: <https://qz.com/731725/scientists-have-found-a-way-to-genetically-engineer-the-goodness-of-fish-oil-in-a-widely-used-plant-oil/>

- 2.1.1 The world market for fish oils has grown quickly over the last 25 years. Suggest ONE advantage of growing genetically modified (GM) rapeseed crops for the production of fish oils.

(1)

- 2.1.2 Suggest why some people are concerned about the transfer of genes from one species to another, especially between animals and plants.

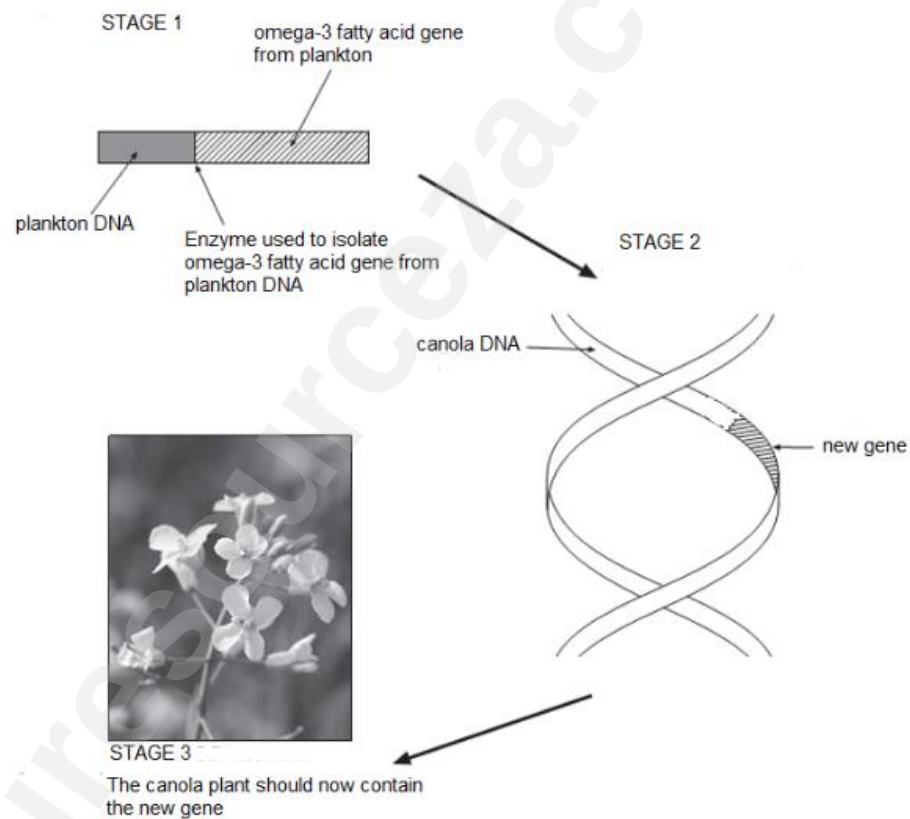
(1)

- 2.1.3 Explain what is meant by the term “transgenic seeds”, by referring specifically to the above passage.

(2)

- 2.1.4 Scientists isolated the omega-3 fatty acid gene of a microalgae, a type of plankton, and transferred it to a canola plant. The canola plant will now produce omega-3 fatty acids.

A simplified diagram of this process is shown below.



- a) Name the enzyme used to “isolate” the omega-3 fatty acid gene from the plankton DNA.

(1)

- b) Name the enzyme used to join the new gene into the canola DNA.

(1)

- c) Outline a basic technique for the production of genetically modified crops, like canola, using *Agrobacterium tumefaciens*, a soil bacterium.
Write your answer in the form of a flow diagram.

(6)

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- 2.2 Read the information below, written by Dr Brian Jones and published in the **GroundCover™ Supplement**.

The plant that serves as ‘lab rat’ for the brassica world, *Arabidopsis thaliana*, is opening the door to **improved yield and water use efficiency in canola** by facilitating the discovery of beneficial gene mutations.

Brassicas such as canola (*Brassica napus*) are closely related to *Arabidopsis* and as a result there are overarching similarities in their genomes. A mutation in *Arabidopsis* has been discovered which results in impressive production gains.

A University of Sydney project, in gene editing, is attempting to manipulate a canola gene to mimic this mutation identified in *Arabidopsis* which promises production gains: more seeds and higher oil content per plant.

- 2.2.1 Explain what a “gene mutation” is.

(2)

- 2.2.2 The process of DNA manipulation in *Brassica napus* and *Arabidopsis* is particularly accessible to scientists. Why?

(2)

- 2.2.3 Explain a benefit of being able to replicate the mutation found in *Arabidopsis* in canola crops.

(2)

- 2.2.4 From the text, identify the correct biological term for each of the statement/description below.

- a) The complete set of genetic information material present in an organism or cell.

(1)

- b) A genetic engineering technique which allows DNA to be inserted, deleted or replaced. (1)
-

- 2.3 Study the following extract from a local news paper and answer the questions that follow.

Rebirth of the quagga planned

The South African museum in Cape Town has started a zebra breeding centre in an effort to re-breed the quagga, according to the South African Journal of Science. For a long time, there has been a dispute in scientific circles as to whether the quagga, extinct for 100 years, is a species of zebra or merely a colour variation of the Plains zebra.

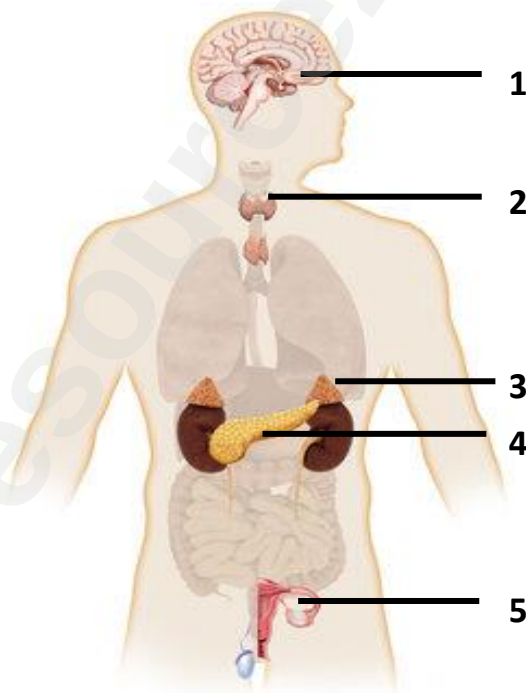
“Perhaps the quagga is not strictly speaking extinct at all; its genes are siluted in and dominated by those of the Plains zebra. In which case, it should be possible to retrieve them by selective breeding,” said the report.

- 2.3.1 If a quagga is a colour variation of the Plains zebra, explain how two Plains zebras might give rise to a quagga. You may use genetic diagrams to assist in your explanation. (5)

- 2.3.2 Do you believe that scientists should be expending their efforts on this work – or are there other fields where they could better use their time and finances?
Explain THREE convincing arguments to support your opinion.

(6)

- 2.4 Study the diagram of the human endocrine organs below and answer the questions that follow.



- 2.4.1 Give the number AND name of the gland that:

a) Is known as the master gland:

(2)

- b) Produces the hormone involved in re-absorption of salts in the kidney:

_____ (2)

- c) Produces the hormone glucagon.

_____ (2)

2.4.2 Refer to the gland labelled number 2 in the diagram.

- a) Name the hormone secreted by this gland.

_____ (1)

- b) Name the micronutrient necessary for this gland.

_____ (1)

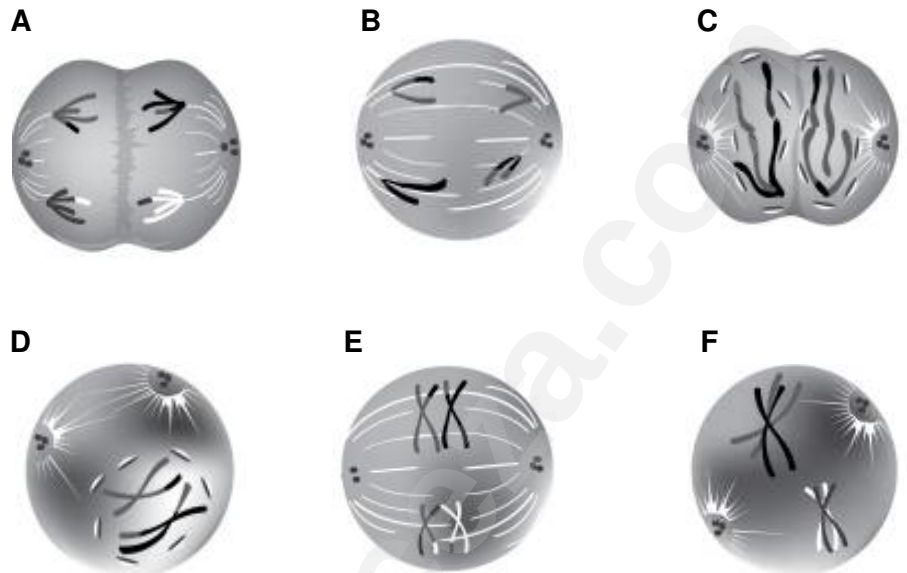
- c) Name the condition that under-secretion of this hormone would cause in adults.

_____ (1)

[40 MARKS]

QUESTION 3

- 3.1 Study the images below. A to F shows various stages of meiosis in a generalised animal cell. The images are placed in random order and do not correspond to the correct order of the stages of meiosis.



Select the letter (A, B, C, D, E or F) that best matches the description for each phases listed below. Some letters may be used more than once.

	Description	Letter
3.1.1	Phase during which homologous pairs of chromosomes align to equator.	
3.1.2	Final phase of meiosis that results in gametes.	
3.1.3	First phases of meiosis.	
3.1.4	Phase during which homologous chromosomes are separated to opposite ends of the cell.	
3.1.5	Phase following brief interkinesis.	
3.1.6	Phase during which sister chromatids are moved to opposite ends of the cell.	

(6)

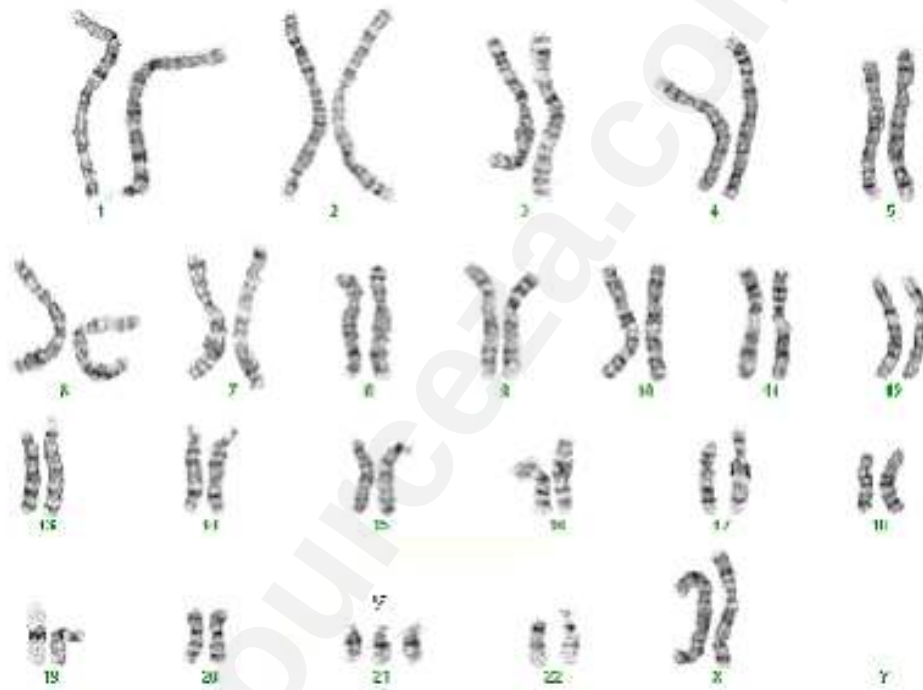
3.1.7 Name a process that results in the formation of genetic variation in:

a) Meiosis I: _____

b) Meiosis II: _____

(2)

3.2 Study the diagram below and answer the questions that follow.



3.2.1 Besides a Down Syndrome diagnosis, what other ONE conclusion can you make about this individual's karyotype?

(1)

3.2.2 Were these cells taken from a somatic cell or a gamete? Give a reason for your answer.

(2)

- 3.2.3 Describe how the occurrence of the Down's syndrome relates to the age of the mother. Give a molecular reason for why this relationship occurs.

(3)

- 3.2.4 Amniocentesis is often recommended for older pregnant women in order to make a prognosis to determine if their embryo has Down Syndrome. Based on these tests, women may decide to terminate their pregnancy.

In the United States, it is widely estimated that 60% - 90% of Down Syndrome prognoses results in the intentional termination of pregnancy.

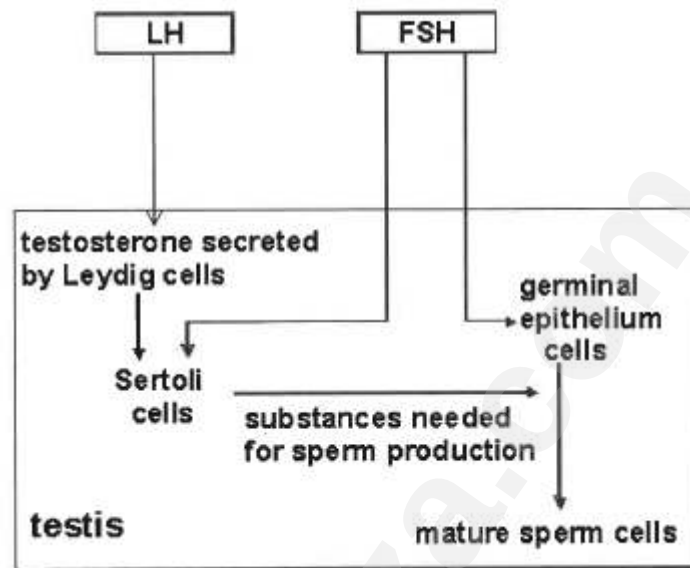
Do you believe the **rate** of termination in Down Syndrome pregnancies is justifiable? Give TWO reasons for your answer.

(3)

- 3.2.5 What is the role of a genetic counsellor in such cases? Mention the areas of specialties that genetic counsellors need to be proficient in.

(4)

- 3.3 The flow chart below summarises the way in which the process of sperm formation is thought to be controlled by hormones.



- 3.3.1 Name the gland that produces FSH.

(1)

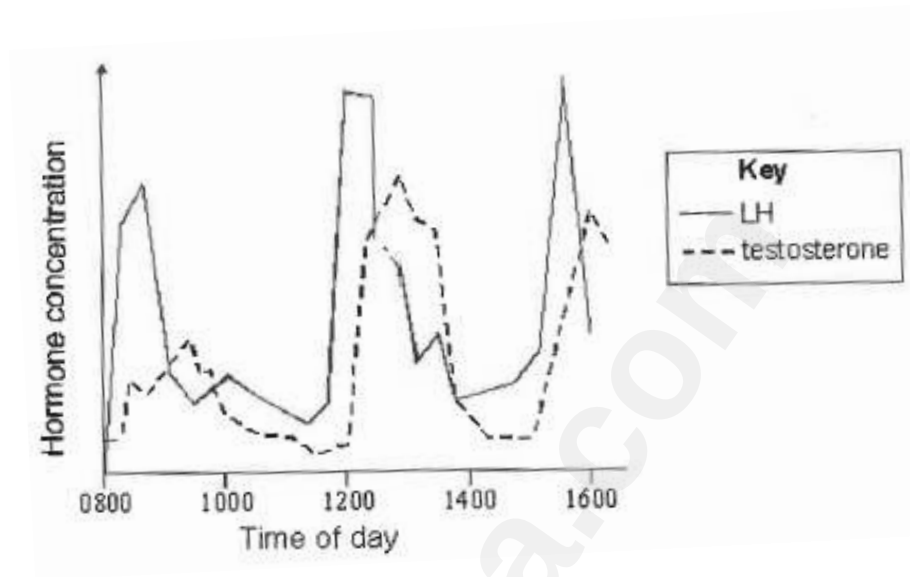
- 3.3.2 Give the percentage of each of the following types of cells that would contain a Y chromosome:

a) Sertoli cells: _____

b) Mature sperm cells: _____

(2)

- 3.3.3 Study the graph below that shows the changes in LH and testosterone concentrations in the blood of an adult man.



Explain how the data shown in the graph supports the information in the flow chart in 3.3.

(3)

- 3.3.4 Study the extract, adapted from *Nature Communication* (23 February 2023), below.

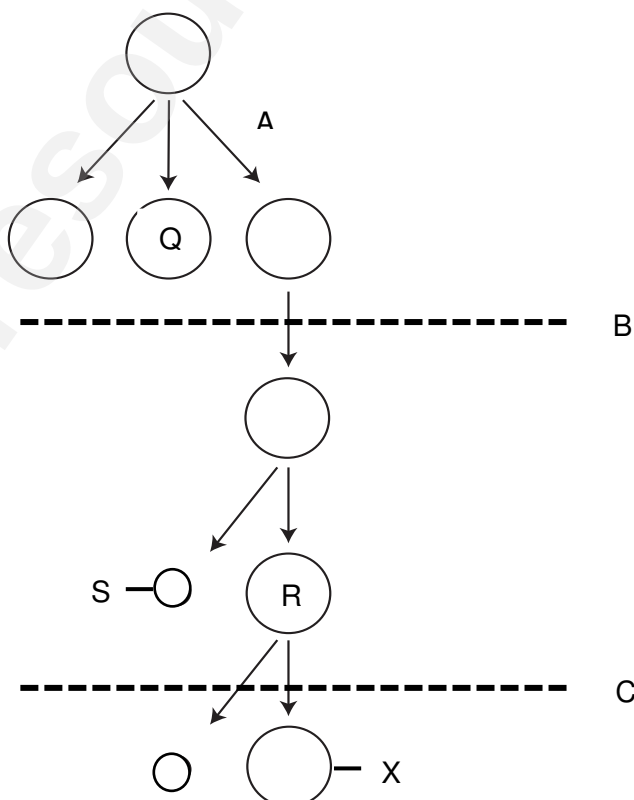
A new experimental approach to male birth control immobilizes sperm

The existing options for male contraception are condoms, vasectomies or abstinence. This results in the work of preventing unwanted pregnancies falling to women. However, findings from a new study have found a form of male contraception that functions by immobilising sperm. Thus far, the study has only been completed in mice. There is high hopes that this fast-acting form of birth control will yield similar results for human males.

In your opinion, do you believe more research funding and resources should be spent on developing forms of male contraceptives? Give TWO valid explanations to your decision.

(3)

- 3.4 Study the diagram below before answering the questions that follow.



3.4.1 Provide a suitable heading for the diagram above.

(1)

3.4.2 Name the processes occurring at A, B and C.

A: _____
B: _____
C: _____

(3)

3.4.3 Provide the chromosome number that would occur in structures Q, R and S.

Q: _____
R: _____
S: _____

(3)

3.4.4 Name the structures that are labelled as Q, S and X.

Q: _____
S: _____
X: _____

(3)

[40 MARKS]

TOTAL: 120 MARKS