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SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2019

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: LIFE SCIENCES

LEARNER BOOKLET

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SESSION NO: 2
TOPIC: MEIOSIS

Note: *Briefly revise Mitosis. You must understand the difference between Mitosis and Meiosis.*
You must understand the relevance of the crossing over in Prophase 1 and random arrangement in metaphase as this forms the basis and grounding for genetic variation and hereditary characteristics.

Learn the relevance of diseases and syndromes resulting from mutations caused during meiosis.

DNA replication

Single chromosome before Replication (unreplicated)	**Double chromosome with two chromatids after DNA replication (replicated)**

TYPICAL EXAM QUESTIONS

SECTION A:
Question 1.1: 10 minutes ***(Taken from various NSC Paper 1 & 2)***

Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A-D) next to the question number (1.1-1.10) in your answer book, e.g. 1.11.D

1.1. The nucleus of the somatic cells of a human contains:
   A. 46 identical chromosomes
   B. 23 different chromosomes
   C. 46 pairs of chromosomes
   D. 23 pairs of chromosomes

1.2. Mitosis is responsible for the following in plants and animals
   A. growth and repair
   B. gamete formation
   C. reduction division
   D. genetic variation

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1.3. The number of chromosomes in a zygote….
A. diploid
B. half the number in a gamete
C. haploid
D. triploid

1.4. Karyokinesis begins during which phase?
A. Prophase
B. Metaphase
C. Anaphase
D. Telophase

1.5. The most important reason for meiosis to take place is…..
A. the production of four gametes per mother cell to improve the chances of fertilization being successful
B. the doubling of the chromosome number of each cell
C. the production of haploid gametes to ensure that the chromosome number is diploid after fertilization
D. the production of a diploid number of chromosomes in the gamete

1.6. During the process of meiosis….
A. two identical daughter cells result
B. four identical daughter cells are formed
C. the chromosome number remains the same
D. four unidentical daughter cells result

1.7. Cytokinesis is the ……
A. division of the nucleus
B. fusion of the nuclei
C. division of the cytoplasm
D. cytoplasmic streaming

1.8. When daughter cells with 20 chromosomes are formed by cell division, the following will result:
A. 20 chromosomes after mitosis; 20 chromosomes after meiosis
B. 20 chromosomes after mitosis; 10 chromosomes after meiosis
C. 40 chromosomes after mitosis; 20 chromosomes after meiosis
D. 10 chromosomes after mitosis; 10 chromosomes after meiosis

1.9. Place the following steps that occur in meiosis in order:
1. crossing over of the chromatids 2
2. lining up of paired chromosomes at the equator 3
3. pairing of homologous chromosomes 1
4. complete separation of chromatids 4

A. 1, 2, 3, 4

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B. 2, 3, 4, 1
C. 3, 1, 2, 4
D. 4, 1, 2, 3

***(With this type of question:** read through options 1 to 4 and tick those that are correct and apply to the question. Cross those that do not. Select your answer from the ticked options)*

1.10. Why does crossing over /chiasma take place during meiosis?
A. to ensure that the chromosomes divide evenly
B. to ensure that characteristics from the mother are transferred to the father
C. to ensure that cell division can take place
D. to ensure that that genetic variation is passed on to all offspring

(10 x 2) (20)

Question 1.2: 5 minutes ***(Taken from various NSC Paper 1 & 2)***

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 phase in meiosis in which chromosomes are pulled apart.
1.2.2 Structures that form spindle threads during meiosis.
1.2.3 Chromosomes that are identical in shape and appearance that code for the same set of characteristics.
1.2.4 Phase in meiosis in which chromosomes are arranged singly at the equator
1.2.5 Phase in meiosis in which crossing over occurs.
1.2.6 Point of overlap of chromatids during crossing over.
1.2.7 Genetic disorder caused by the presence of an extra copy of chromosome 21.
1.2.8 The structure holding two chromatids together in a chromosome.
1.2.9 A phase in meiosis in which two cells are formed having half the chromosome complement as the original parent cell.
1.2.10 Structures to which chromosomes are attached during Metaphase II.

(10)

Question 1.3: 6 minutes
Indicate whether each of the statements 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 1.3.6) in your ANSWER BOOK.**

1.3.1 Having one set of chromosomes in each cell.	A: Haploid B: Diploid
1.3.2 Bivalents occur	A: Mitosis B: Meiosis
1.3.3 Chromosome condition describing the presence of two sets of chromosomes in each cell	A: Diploid B: Haploid
1.3.4 No crossing over	A: Mitosis B: Meiosis

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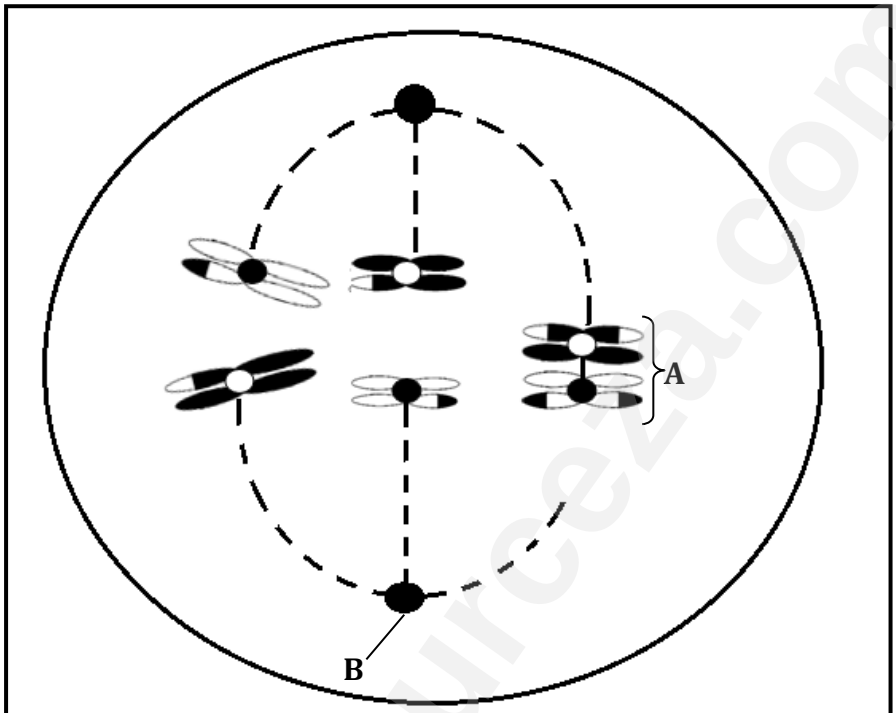
1.3.5 The two strands that make up a chromosome	A: Spindle threads B: Bivalents
1.3.6 New cells are formed	A: Mitosis B: Meiosis

(6×2=12)

Question 1.4: 10 minutes (***Taken from CAPS FS Sept. 2015 Paper*** 2)

The diagram below represents a cell during meiosis.



Cell during a phase of meiosis

1.4.1 Give the label for part **B**. (1)

1.4.2 Which process has led to the appearance of the chromosomes at **A**? (1)

1.4.3 Which phase of meiosis is illustrated above? (1)

1.4.4 Give ONE visible reason for your answer in QUESTION 1.4.3. (1)

1.4.5 How many chromosomes will be present in a normal gamete of the species who's cell is represented above? (1)

1.4.6 What will the chromosome number of the four gametes formed at the end of Meiosis **II** be? (2)

1.4.7 If a gamete resulting from the error in meiosis (**A**) is involved in fertilisation with a normal gamete, explain how the new zygote will be affected. (3)

(10)

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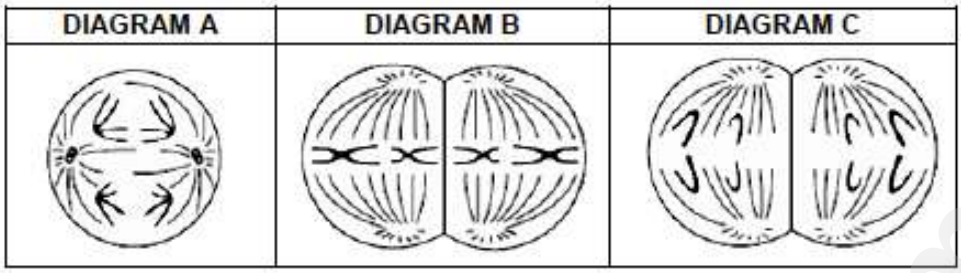
SECTION B:

QUESTION 2: 5 minutes ***(Taken from NSC Feb/March 2013 Paper 1)***

Study the diagrams below representing various phases of meiosis in an organism.



2.1. Which diagram (**A**, **B** or **C**) represents meiosis I? (1)

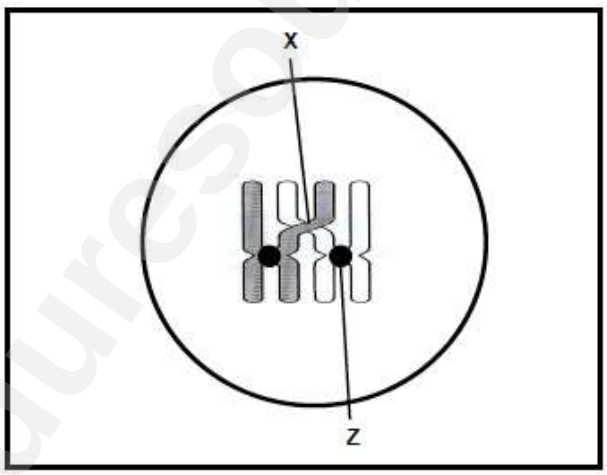
2.2. Suggest why the chromosomes in diagram **B** will be **genetically different** from that of the parent cell at the beginning of meiosis. (1)
(Hint: crossing over in meiosis I – why is this relevant?)

2.3. How many chromosomes will each daughter cell have at the end of this cell division? (1)

2.4. Give TWO reasons why this type of cell division is important. (2)
(5)

QUESTION 3: 5 minutes ***(Taken from NSC Nov 2012 Paper 1)***

The diagram below shows crossing over in a pair of homologous chromosomes.



3.1. Identify the point **X** and part **Z** respectively. (2)

3.2. Give ONE observable reason why the chromosomes above are regarded as **homologous.** (1)

3.3. Give ONE reason why crossing over is important. (1)

3.4. Name ONE **other process** occurring during meiosis that has the same

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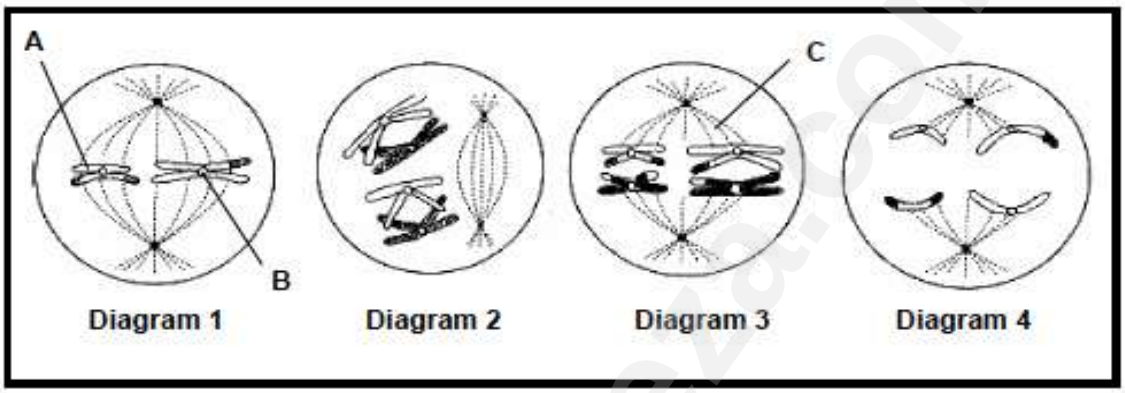
importance as crossing over. (1)
(Hint: this takes place during metaphase)

3.5. If a mouse egg cell contains 20 chromosomes, how many chromosomes will there be in its skin cell? (1)
(6)

QUESTION 4: 12 minutes ***(Taken from NSC Feb/Mar 2011 Paper 1)***
Study the following diagrams representing different phases of meiosis.



4.1. Label structures **A**, **B** and **C**. (3)

4.2. Which phase is represented by:
(a) Diagram 1 (1)
(b) Diagram 2 (1)

4.3. Write down the numbers of the diagrams to show the correct sequence in which the phases occur. (2)
(Hint: IPMAT)

4.4. Tabulate THREE **differences** between the first and second stages of meiosis. (7)

4.5. Name and explain **TWO processes/mechanisms** that ensure that the gametes produced at the end of meiosis are genetically different from each other. (4)
(18)

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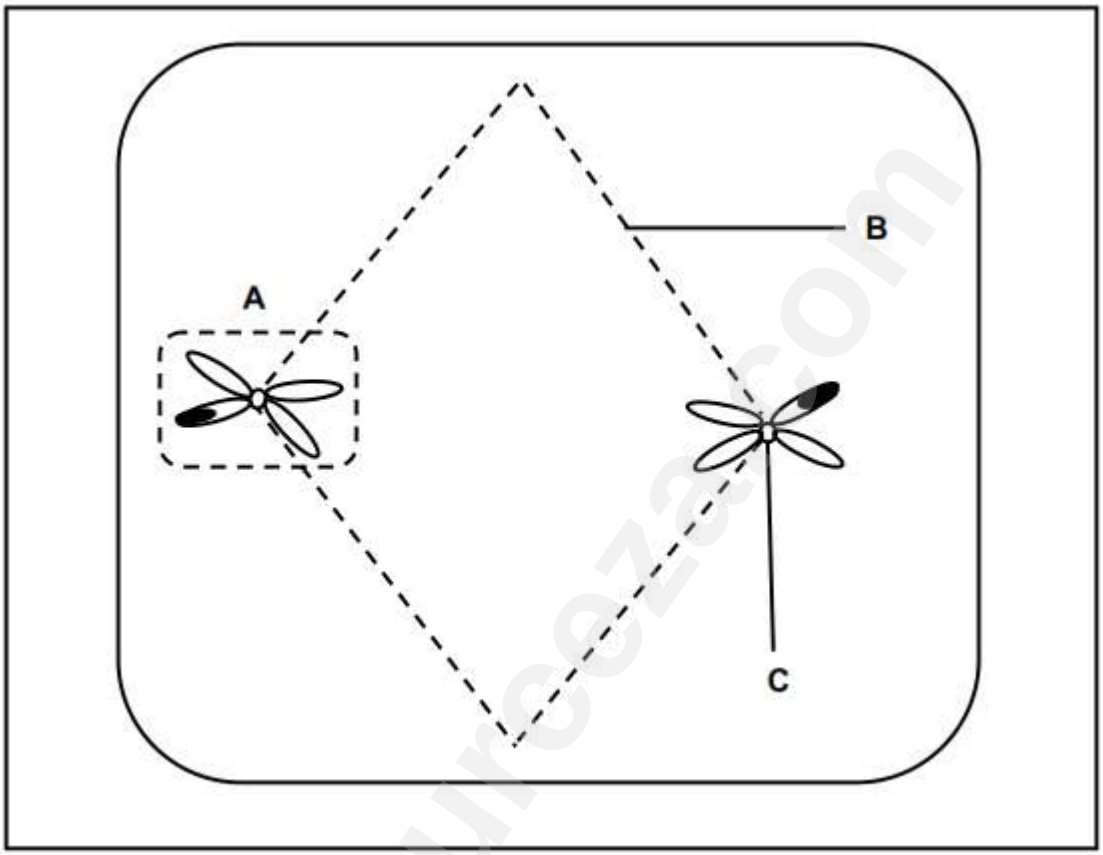
QUESTION 5 10 minutes

The diagram below illustrates a phase in meiosis.



5.1 Identify part:

(a) **A** (1)

(b) **B** (1)

(c) **C** (1)

5.2 Identify the phase illustrated above. (1)

5.3. Give a reason for your answer to QUESTION 5.2. (2)

5.4 Draw a diagram of the cell above as it would appear during **anaphase I**. (4)

(10)

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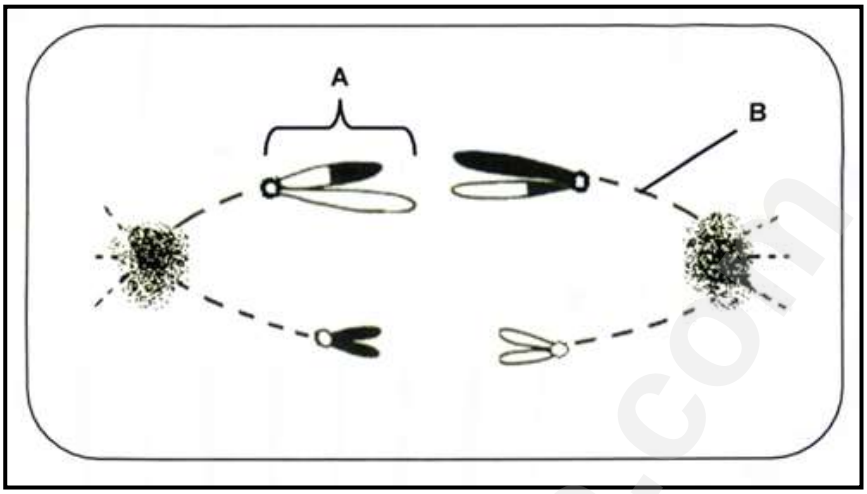
QUESTION 6 8 minutes

The diagram below represents a phase of meiosis.



6.1 Provide labels for parts **A** and **B** respectively. (2)

6.2 Identify the phase illustrated above. (1)

6.3 Give a reason for your answer to QUESTION 6.2. (1)

6.4 How many chromosomes would be found in each gamete at the end of this division? (1)

6.5 How many chromosomes were present in the original mother cell? (1)

6.6 Give the name of the process responsible for the mixed appearance of structure **A**. (1)

6.7 State ONE place where meiosis takes place in the male body. (1)
(8)

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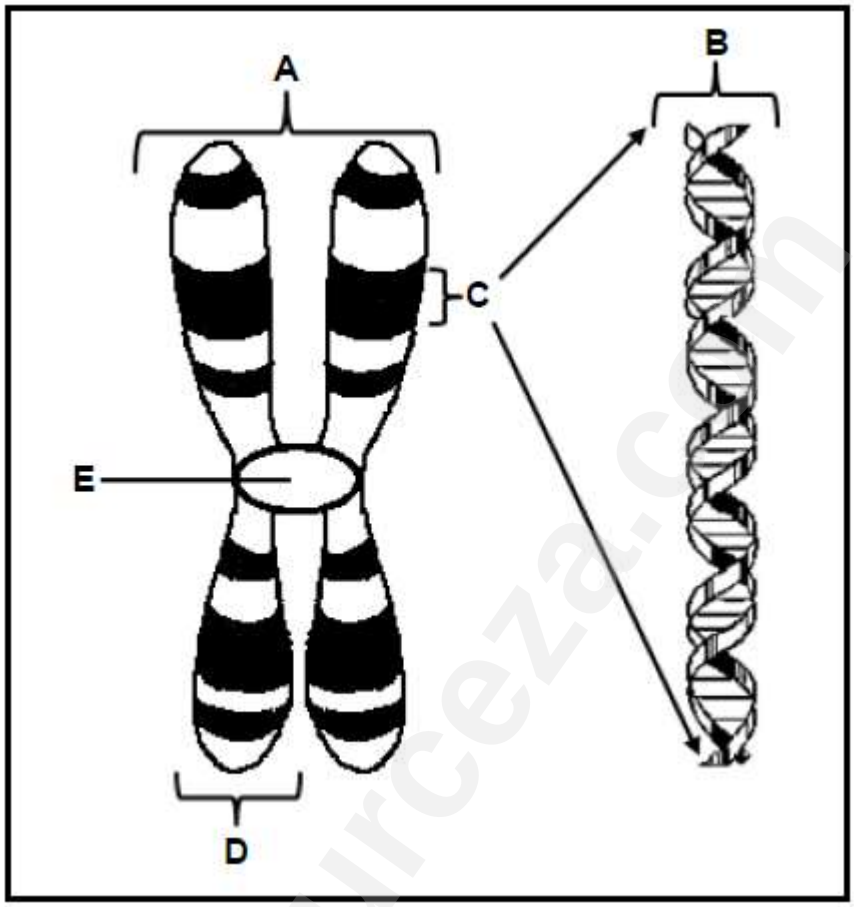
QUESTION 7 8 minutes ***(Taken from NSC Nov 2018 Paper 2)***

The diagram below shows the structure of a chromosome.



7.1 Identify parts **D** and **E**. (2)

7.2 How many pairs of chromosomes are found in a normal human somatic cell? (1)

7.3 Give only the LETTER of the part that:
(a) Attaches to the spindle fibres during cell division (1)
(b) Represents a gene (1)

7.4 Name:
(a) TWO organelles in an animal cell where DNA is found (2)
(b) The natural shape of a DNA molecule (1)
(c) The process whereby DNA makes an identical copy of itself (1)
(9)

SECTION C:
QUESTION 8: 20 minutes ***(Taken from NSC Nov 2011 Paper 1)***

(Hint: Underline the key concepts in the question. This will tell you what you must cover in the essay.)

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Describe the mechanisms by which meiosis contributes to **genetic variation** and describe how **abnormal meiosis** leads to **Down's syndrome.** (17)

ASSESSING THE PRESENTATION OF THE ESSAY

Criterion	Relevance (R)	Logical sequence (L)	Comprehensive (C)
Generally	All information provided is relevant to the topic	Ideas are arranged in a logical/cause-effect sequence	All aspects required by the essay have been sufficiently addressed
In this essay	Only information relevant to crossing over ,random arrangement of chromosomes and Down's Syndrome is given	Information regarding crossing over , random arrangement of chromosomes and Down's Syndrome is given in a logical order.	At least **five** correct points included on crossing over and **three** on random arrangement of chromosomes and **four** on Down's syndrome must be given
Mark	1	1	1

Synthesis : (3)
(20)

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SESSION NO: 3
TOPIC: GENETICS AND INHERITANCE PART 1

Note to Learner: *You MUST understand the link between meiosis and genetics. During the crossing over in prophase I of meiosis, chromosomes share information and then during metaphase I, arrange randomly. This determines the combination of chromosomes and genes that you have as an individual. Genetics determines individual variation (to be different) and survival of the fittest. You MUST have a clear understanding of the genetic terminology in order to study genetics and answer genetic problems.* ***Mendel's Laws are very important*** *- understand the concepts of dominance and how this plays a role in monohybrid crosses (mono = one = one characteristic or trait).* ***Be aware of confusing the word 'cross/ crossing' with 'crossing over' in Meiosis.*** *You cross individuals and calculate the chances of a characteristic or trait being in the offspring. You must be clear of the difference between these two terms. Questions on blood group inheritance and sex determination are often asked. The more examples of genetic crosses that you do, the better you will do. Pedigree diagrams are a popular way to express family history and are often asked in exams. Make sure you know how to answer them. There are basically* ***FOUR crosses****. If you know these crosses, you should not have a problem.*

Complete dominance:
We will use one general trait like hair colour:
B = brown hair colour (dominant trait)
b = blonde hair colour (recessive trait)

CROSS EXAMPLE 1: (Homozygous dominant x Homozygous recessive) [OFTEN ASKED]

P_1 (first parent generation)
Phenotype: Brown x blonde
Genotype: BB x bb
Meiosis
Gametes: B B x b b
fertilization

	B	**B**
b	Bb	Bb
b	Bb	Bb

F_1 (first filial generation = first offspring)
Genotype: Bb 4:4 heterozygous offspring
Phenotype: 100% brown

CROSS EXAMPLE 2: (Heterozygous x Heterozygous) [OFTEN ASKED]
P_1 **Phenotype:** Brown x Brown
Genotype: Bb x Bb
Meiosis

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Gametes: B b x B b

Fertilization

	B	**b**
B	BB	Bb
b	Bb	bb

F_1 Genotype: 1:4 BB homozygous offspring
2:4 Bb heterozygous offspring
1:4 bb homozygous
Phenotype: 75% brown and 25% blonde

CROSS EXAMPLE 3: (Homozygous dominant x Heterozygous)

P_1 **Phenotype:** Brown x Brown
Genotype: BB x Bb
Meiosis
Gametes: B B x B b
fertilization

	B	**B**
B	BB	BB
b	Bb	Bb

F_1 Genotype: 2:4 BB homozygous offspring
2:4 Bb heterozygous offspring
Phenotype: 100% brown

CROSS EXAMPLE 4: (Homozygous recessive x Heterozygous)

P_1 **Phenotype:** Blonde x Brown
Genotype: bb x Bb
Meiosis
Gametes: b b x B b
fertilisation

	b	**b**
B	Bb	Bb
b	bb	bb

F_1 **Genotype:** 2:4 Bb heterozygous offspring
2:4 bb homozygous offspring
Phenotype: 50% brown and 50% blonde

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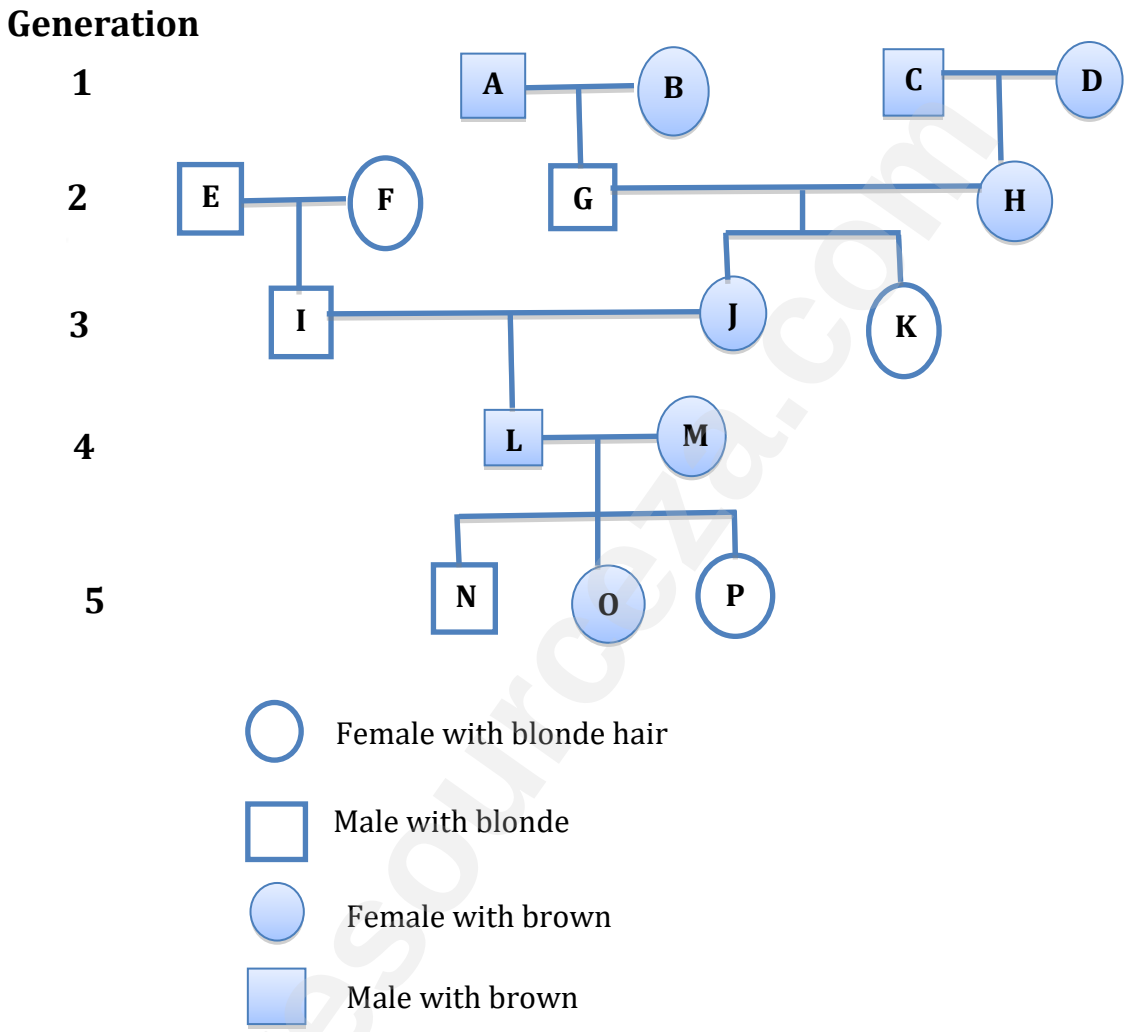
HOW TO TACKLE ANSWERING PEDIGREE DIAGRAM QUESTIONS



Analysing the genetic lineage in a pedigree diagram:

Step 1: Mark all the **homozygous recessive** individuals with blonde hair. This will be all the white shapes: E, F, G, I, K, N and P as **bb** on the pedigree chart.

Step 2: Work from the generation line 5 <u>up towards</u> the generation line 1 so that you start with the last offspring on the pedigree diagram. To produce an offspring with **bb**, BOTH parents must have at least one homozygous recessive gene (**b**). If the parent is a white shape – then the parent is **bb** and already marked. If the parent is a shaded shape and produced a **bb** offspring, then the parent must be heterozygous **Bb**. Mark the **Bb** parents on the pedigree diagram.

Step 3: Parents that are shaded shapes and produce only shaded shape offspring, can be homozygous **BB** or heterozygous **Bb**. Look to the

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next generation and then work backwards. Mark the parents on the pedigree diagram.

Step 4: Answer the questions that relate to the pedigree diagram.

Try to work out the genotype of A, B, C, D, H, J, L, M and O on your own first.

Let us see if you were right:

- A and B are **Bb** because they produce G (**bb**)
- If C is **BB** then D must be **Bb** or C is **Bb** then D is **BB** because H must be **Bb** to produce K (**bb**)
- J is **Bb** because G is **bb** and H is **Bb** (produced sister K - **bb**)
- L and M are both **Bb** because parent J is **Bb** and I is **bb** so they cannot be homozygous BB AND L and M produce a son (N) and daughter (P) that are both homozygous **bb**
- Offspring O can be either **BB** or **Bb** because both parents are heterozygous **Bb**

Examples:

Incomplete dominance in flowers:

Colour key: **R** (red) W (white)

P_1 Phenotype : red x white

Genotype: RR x WW

Meiosis

Gametes R R x W W

Fertilisation

F_1 Genotype: 4:4 RW

Phenotype: 100% pink

Incomplete dominance in humans:

Curly CC plus Straight SS = Wavy CS

Blood groups:

Phenotype/Blood type	Genotype
A	$I^A I^A$
	$I^A I$
B	$I^B I^B$
	$I^B I$
AB	$I^A I^B$
O	i i

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TYPICAL EXAM QUESTIONS

SECTION A:
Question 1.1: Multichoice 7 minutes (Taken from various sources)
(Note: *When answering multi-choice questions:*
1. *Read the question while covering the answers.*
2. *Think of the correct answer.*
3. *Look for your answer.*
4. *Write the letter down on your answer sheet.*

BUT: *If you do not know the answer after point 1 and 2, then:*
5. *Look at the options.*
6. *Try to think of why an option is wrong for the question and cross it out. If there is an option that you don't know, write a ? next to this option.*
7. *If you still do not know the answer, then select the ? option)*

(Reminder: there are only 4 basic types of crosses. Make sure you are able to use them properly. Do a quick cross in pencil, next to the relevant question to find the correct answer)

1. The term for the physical appearance of an organism due to the genetic composition:
   A heterozygous
   B genotype
   C homozygous
   D phenotype

2. When the allele genes on homologous chromosomes differ, the organism is
   A homozygous
   B dominant
   C heterozygous
   D recessive

3. The genotype of a plant that results from a cross between a plant with red flowers (RR) and white flowers (rr) will be:
   A RR
   B Rr
   C rr
   D rR

4. Choose the correct cross if the result is 50% homozygous dominant and 50% heterozygous in the F_1 generation:
   A Bb xbb
   B BB x Bb
   C BB x bb
   D Bb x Bb

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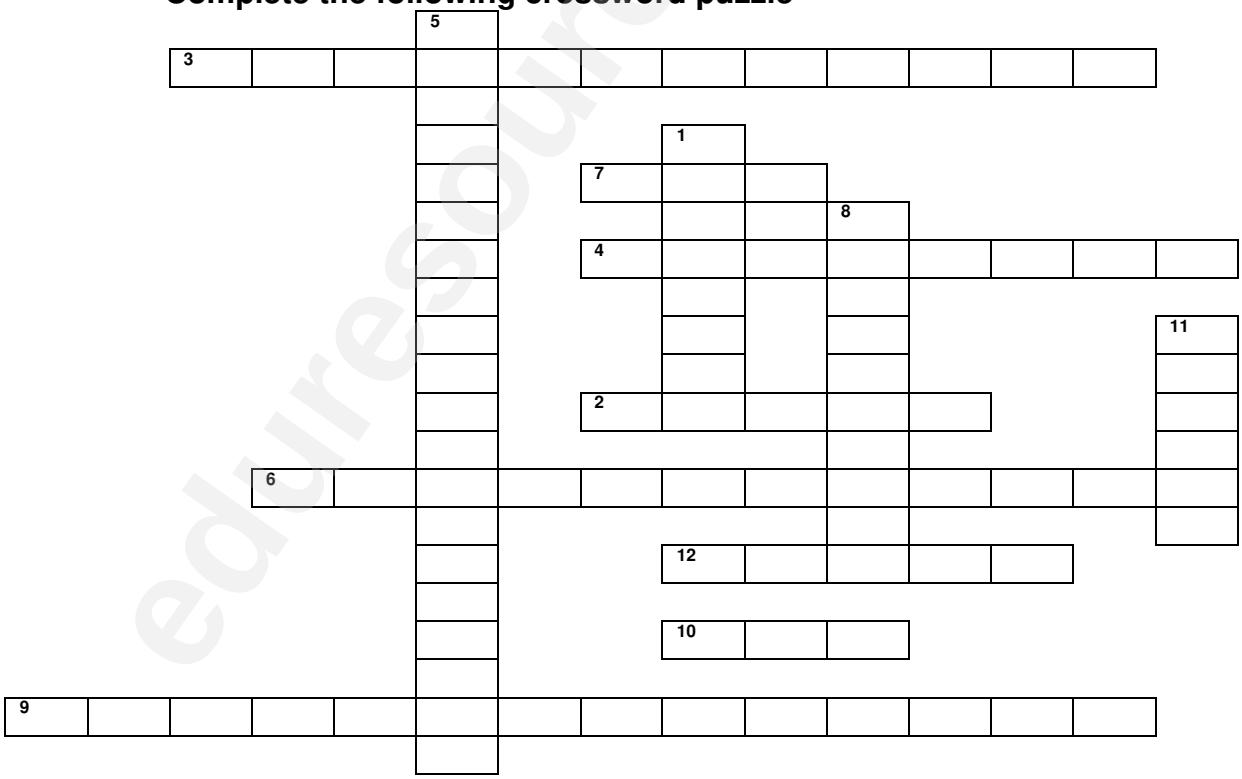
5. Two white heterozygous cats were crossed where white fur is dominant over black fur. Choose the correct phenotype of the F_1 generation:
   A 25% white and 75% black
   B 50% black and 50% white
   C 25% black and 75% white
   D 100% white

6. A heterozygous red flower plant was crossed with a homozygous white flower plant and yielded 300 new plants. What number of the new plants will carry white flowers?
   A 150
   B 225
   C 300
   D 196

7. The babies of a purebred while rabbit were crossed with a purebred black rabbit. Black hair dominates over white hair. The offspring of the **F_2** will be:
   A all black
   B all white
   C 75% black and 25% white
   D 75% white and 25% black (7 x 2) **[14]**

Question 1.2: 12 minutes

Complete the following crossword puzzle



Across

2 Basic unit of heredity: codes for your traits

Down

1 Genetic make-up in letters; combination of alleles

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3	Having two different alleles	**5**	Traits are controlled by genes on the X or Y chromosome
4	Trait always expressed; only need one allele to be expressed	**8**	Co-dominant disorder that is seen mostly in African Americans
6	The father of genetics	**11**	Circles in a pedigree represent
7	Plants that Gregor Mendel used		
9	Recessive disorder that causes abnormal build-up of mucus in lungs		
10	A recessive disorder that is treated by a special diet		
12	Squares in pedigrees represent		

Question 1.3: 11 minutes *(Taken from DoE November 2008 Paper 1)*
(The following question is based on a pedigree diagram. Please see the content summary for hints to answer questions on pedigree diagram. In this diagram, the family history is shown as a schematic diagram. Always identify the recessive individuals first. Write their trait symbols next to the number e.g.: S = straight hair and s = wavy hair. So ss = homozygous for the recessive trait)

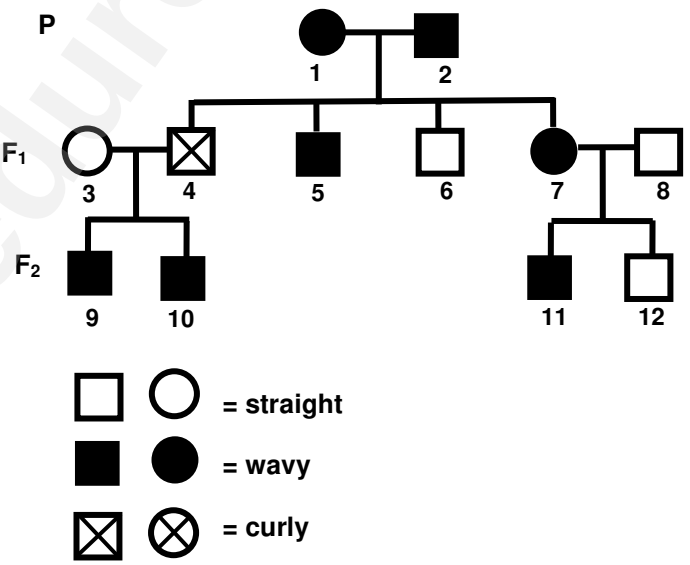
The eight items below are based on the pedigree diagram which shows the phenotypes of offspring from wavy-haired parents. Write down the letters A, B, C or D according to the following key:

A - if the statement is TRUE

B - if the statement is FALSE

C - if there is a 25% chance that the statement is TRUE

D - if there is a 50% chance that the statement is TRUE



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1.3.1. Wavy hair is dominant. (1)
1.3.2. Individual 1 is homozygous (1)
1.3.3. If individual 6 married a woman with straight hair, all of the offspring would have straight hair. (1)
1.3.4. Individual 4 is homozygous. (1)
1.3.5. One of the parents of 2 had the same genotype as 2. (1)
1.3.6. If 10 married someone with wavy hair, the first child would have wavy hair (1)
1.3.7. If 1 and 2 had another child, the child would have curly hair. (1)
1.3.8. If 3 and 4 had more children than those shown, they might have straight hair. (1)
(8)

SECTION B:

Question 2: **8 minutes** *(Taken from DoE November 2009 Paper 1)*

Fur colour in mice is controlled by a gene with two alleles. A homozygous mouse with black fur was crossed with a homozygous mouse with brown fur. All the offspring had black fur.

Using the symbols B and b to represent the two alleles for fur colour, show as a Punnit square, a genetic cross between a mouse that is heterozygous for fur colour with a mouse with brown fur. Show the possible genotypes and phenotypes of the offspring. **(6)**

(Check the content summaries for an example of the 4 possible crosses. Remember to include P_1 and F_1, as well as genotype and phenotype, rations and % in your work.)

Question 3: **5 Minutes** (*Taken from DoE November 2008 Paper 1)*

People with albinism are unable to produce the dark pigment, melanin, in their skin. This condition is caused when an individual is homozygous recessive for this characteristic. The family tree below shows the occurrence of albinism over three generations.

***(*This is a pedigree diagram. Always first mark the homozygous recessive individuals on the diagram before trying to work out the genetic traits for the other individuals. Albinism is homozygous recessive, so an individual with albinism will be 'aa' and a person who is not an albino will be either 'AA' or 'Aa'.)**

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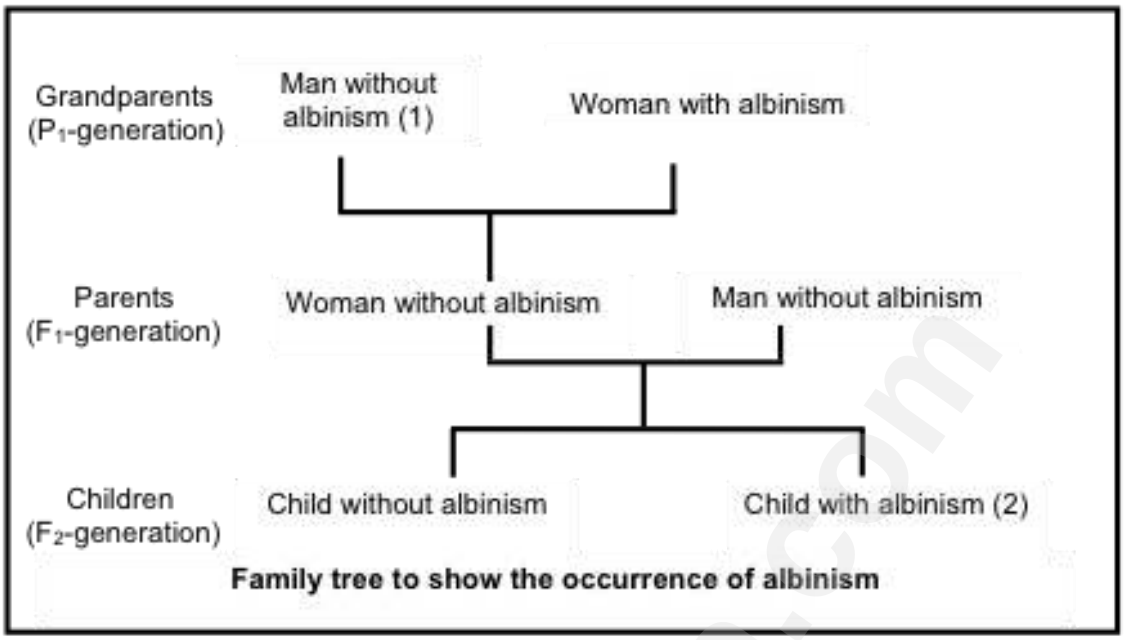

Family tree to show the occurrence of albinism

3.1. Indicate whether each of the individuals below could be homozygous dominant, homozygous recessive or heterozygous:
(a) 1 (2)
(b) 2 (1)

3.2. Explain your answer to QUESTION 4.1 (a). (2)
(5)

Question 4: 6 minutes *(Taken from Free State Prelim 2009)*
Sello crosses two homozygous garden pea plants in the laboratory. Plant A produces yellow peas and plant B green peas. He knows that the gene, for yellow peas (Y), is dominant over the gene for green peas (y). The diagram below shows the results he obtained for two generations of pea plants. Study the diagram and answer the questions that follow:
(A reminder: yellow is dominant and green is recessive. For a pea plant to yield green peas, this plant must be 'yy' – so homozygous recessive. Also refer to Mendel's law of dominance and segregation in the content summary.)

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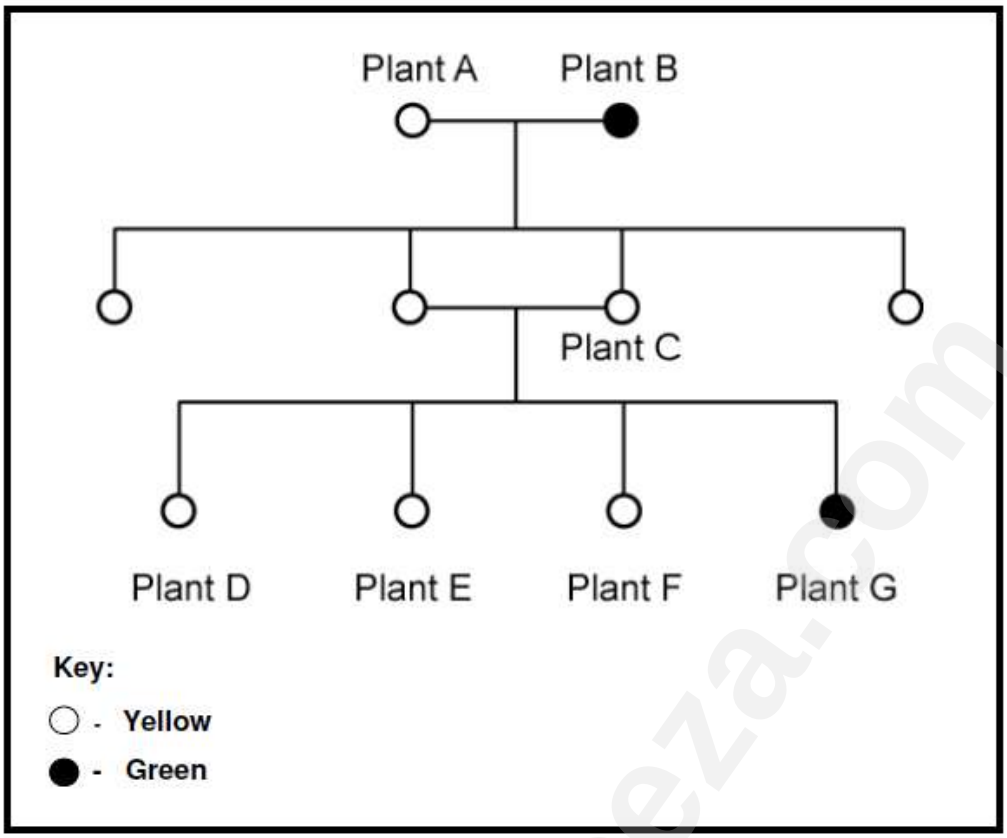

4.1. Give the genotype for plant A and plant B. (2)
4.2. Provide the phenotypic ratios for the F_2 generation. (2)
4.3. If Sello allows plant G to self-pollinate, give the phenotype and genotype of the offspring. (2)
(6)

Question 5: 6 minutes *(Taken and adapted from Study & Master Biology Grade 11)*
Blood typing can be used to identify a parent in that the blood type can prove that a person is not the parent of a child rather than determine without question who the parent is. A, B, AB and O blood groups are the result of three alleles. Allele A and B are incompletely dominant and O is recessive to both A and B. Should the discrepancy continue, tissue typing and DNA fingerprinting will be used. Read through the following information and answer the questions below:

In a maternity ward of a hospital, two newly born babies were mixed up. One baby is blood type O and the other is type A. Both mothers believe the baby with blood type O is their baby. Can you sort it out? On testing the parents' blood it was found that:

1. Mr. Xhosa is blood group AB and his wife is blood group B
2. Mr. Mbundwini is type A.

Who owns baby 'O' and who owns baby 'A'? Explain / show your reasoning. **(12)**

(Remember that in blood groups there are three alleles A, B and O. A and B are co-dominant over O which is recessive. There must be two of the same alleles if a recessive trait is present in the individual)

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Question 6: 12 Minutes *(Taken from DoE Nov 2011 Paper 1)*
Haemophilia is a sex-linked disease caused by the presence of a recessive allele (X^h). A normal father and heterozygous mother have children.
(Remember: X^H is dominant and normal. X^h will carry the recessive haemophilia gene)

6.1. Represent a genetic cross to determine the possible genotypes and phenotypes of the children of these parents. (6)
6.2. What are the chances of the parents having a child that will be a haemophiliac male? (2)
6.3. Explain why the father is not a carrier for haemophilia. (2)
(10)

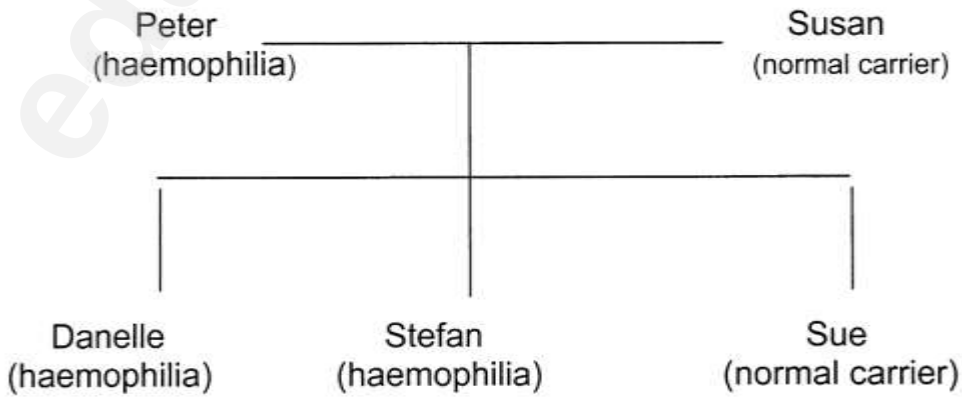
(The following questions were taken from DoE Additional Exemplar 2008 Paper 1 and Gauteng Prelim 2009 Paper 1, DBE Feb 2018, Paper 2)

Question 7: 10 minutes
In mice, brown (B) coat colour is dominant over grey (b) coat colour. Show a cross between a heterozygous parent with a brown coat colour and one with a grey coat colour up to the F_1 generation. Also give the phenotypes of the F_1 generation. **(8)**

Question 8: 8 minutes
Learners want to investigate eye colour in fruit flies *(Drosophila melanogaster)*. Fruit flies can have red (R) eyes or white (r) eyes. Red eye colour is dominant and white eye colour is recessive. Male fruit flies, homozygous for red eye colour, were bred with female fruit flies, homozygous for white eye colour.
Show how the possible phenotypes and the genotypes of the F_1 generation for eye colour may be obtained. **(6)**

Question 9: 10 minutes
Haemophilia is a sex-linked hereditary disease that occurs as a result of a recessive allele on the X-chromosome. Study the family tree below and answer the questions that follow:

(Use the symbols **H** for normal and **h** for haemophilia above the sex chromosomes, for example.: X^HX^h)



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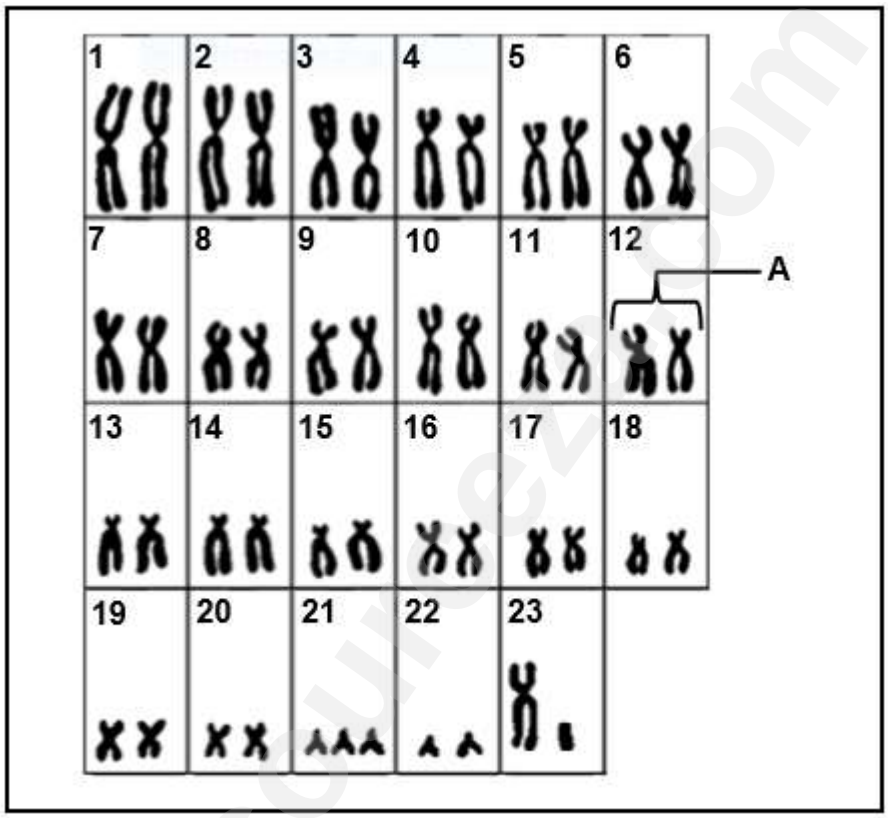
9.1. Write down the genotype of Stefan. (2)
9.2. Peter and Susan would like to have a fourth child. Calculate the percentage probability of this child having haemophilia. (6)
(8)

Question 10: 10 minutes
The karyotype below shows the chromosomes of a person with Down syndrome.



10.1 Give the label for A. (1)

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

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

10.4 What evidence suggests that this is a karyotype of a male? (1)
(4)

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SESSION NO: 4
GENETICS AND INHERITANCE Part 2

Note to Learner:
Mutations, natural selection and genetic engineering: read about genetic engineering so that you form an opinion of whether this is good or bad, but also so that you understand the basic process and the benefits to human being.

- **DNA sequencing:**
  Scientists agree that individual organisms **change** to adapt to the environment. A species is a group of organisms that are **similar in appearance**, share the **same DNA sequences**, perform the **same mating rituals** and **interbreed**. It is the **sequence** of bases in the DNA that is the code for that organism. The **sequence** (order) of bases tells the cell what proteins to make. The **sequence of bases** dictates the sequence of amino acids, which determines the shape of a protein. The **sequence** of the DNA and the number of chromosomes provides evidence of **relationships** between groups of organisms. Similarly, the DNA sequencing of all mammals further suggests **phylogenic relationships**.

- **Mutations**
  A gene mutation is a **change** in the genetic material/DNA sequencing in the cell. A mutations that assist the organism to **adapt** to its environment, is favourable and will become a **fixed mutation**, passed to the next generation. It will ensure variation, **natural selection** and survival of the species by increasing the gene pool. **Lethal mutations** are unfavourable and will result in death. A **neutral mutation** has no immediate effect on the individual. It is passed on to the next generation and when the environment changes, the mutation may assist the organism to adapt and cope with the change.

- **Chromosomal aberrations/anomaly:** when there is an **incorrect number** of chromosomes or a **structural abnormality** in one or more chromosomes. This occurs when there is an error in cell division (**meiosis or mitosis)**. A chromosomal aberration is an **accident and not inherited**, e.g.: when an individual is missing a chromosome from a pair or has more than two chromosomes to a pair. A Down's syndrome baby has **three copies** of chromosome 21, rather than two so the chromosome's **structure is altered.**

- **Genetic Engineering:** the process where scientists alter, swap or manipulate the genes on the DNA, to produce a different organism. Genetic engineering involves the **transfer of genes** from one organism to an unrelated species.

Diabetics are people who cannot produce their own **insulin**. Insulin is a **hormone** needed to regulate blood sugar. Biochemists have devised a way in which to produce artificial insulin. A similar process is used to genetically modify many different organisms. Make sure you know the basic process:

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- Bacteria produce **restriction enzymes** that 'cut' DNA molecules. These restriction enzymes are extracted from the bacteria.
- DNA is removed from a healthy person's pancreas cells.
- Restriction enzymes are used to 'cut' out a piece of DNA, which contains the **genes** that produce insulin.
- When the genes are transferred from one organism's cells to another, the DNA in the recipient cell is called **recombinant DNA**. Insulin is produced by using recombinant DNA in the bacterium called *Escherischia coli* (*E. coli*), which lives in the human gut.
- **Plasmids** are taken out of a bacterium and cut open with the restriction enzyme.
- The human genes are inserted into the plasmid. The healthy bacterium absorbs the plasmids.
- The piece of human DNA continues to produce proteins, which make insulin, inside the bacterium.
- The insulin is then extracted from the bacterium cell.
- Diabetics inject themselves with this insulin everyday, so that they can regulate their blood sugar.

Advantages of GM crops	Disadvantages of GM crops
• Better nutritional value • Greater crop yield resulting in higher food production and long term reduction in costs • Crops are better adapted to less favourable environments and climates • Disease and pest resistant means less insecticides and pesticides are released into the environment • Increased biodiversity as new varieties are developed • Efficient use of scarce agricultural land as well as land that may previously not have been fit	• Possible increase in allergen and carcinogen levels • Nutritional changes and possible toxicity • Traits can be transferred to other species like weeds • Cause un-natural selection pressure • Expensive start-up costs • DNA alteration of the new varieties are owned and controlled by biotechnology company which may lead to issues with ethics and ownership • Lack of transparency regarding what is in our food

Cloning

With cloning, the nucleus of a **somatic** cell (2n) of one organism is removed. An egg cell (n) is taken from an ovary. The nucleus of the egg cell is destroyed. The somatic cell's nucleus (2n) is then placed inside the egg cell. The egg cell is put back into a uterus where it is allowed to grow and differentiate into an embryo. When the baby is born, it is identical to the original organism. A sheep called Dolly was cloned successfully in 1997.

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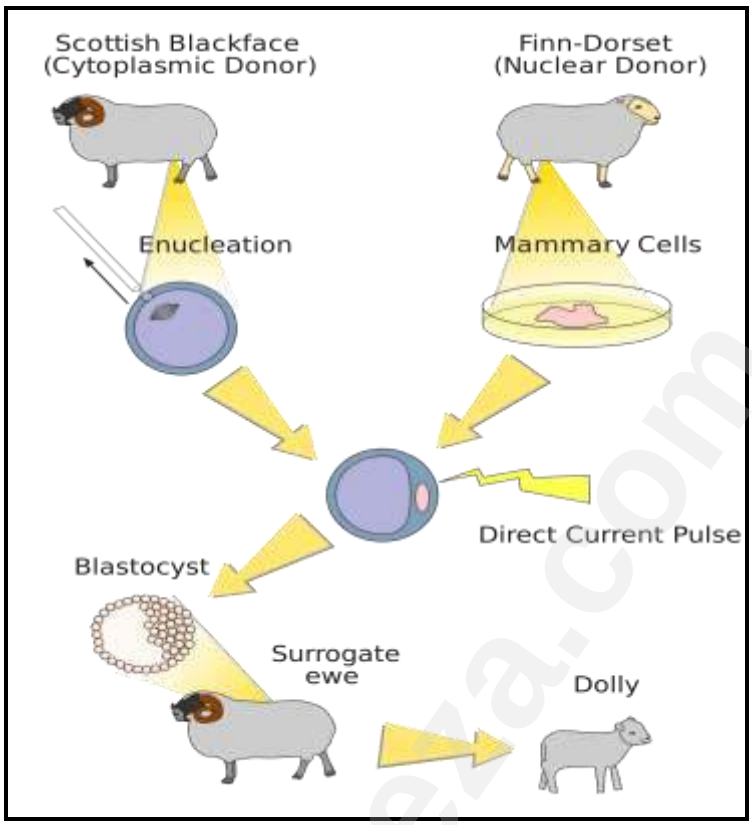

Advantages of Cloning	Disadvantages of Cloning
Produce individuals with desired traits	Objections to interfering with God's creation
Better yields	Reducing the gene pool by reducing variation
Resistant to diseases	Cloned organisms may have developmental problems
Organisms produced in a shorted time	Costly process
Saving endangered species	Generate experimental waste
Produce body parts/organs for transplant	May lead to killing clones for organs/body parts
Produce offspring when organisms are infertile	Cruelty to animals and inhumane behaviour

Stem Cell research:

A stem cell is a cell that has the potential to **regenerate** multiple cell type tissue and self-renew so a stem cell is able to produce new cells over a long term by the process of mitosis. Once mitosis occurs, the cells are able to differentiate into many different types of **specialized cells** and tissue. Stem cells can be harvested from umbilical cord blood (once a baby has been born), a foetal blastocyst and bone marrow.

Stem cell therapy can be used to treat a variety of different human diseases:

- cancers like Leukemia
- degenerative diseases like Multiple Sclerosis
- diabetes mellitus where the pancreas no longer produces insulin

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- muscle damage
- organ damage and
- certain genetic diseases in conjunction with gene therapy

TYPICAL EXAM QUESTIONS

Question 1: 12 minutes *(Taken from DoE Feb/March 2009)*
Read the following passage and answer the questions that follow.

GENETICALLY MODIFIED PIG BRED WITH 'GOOD FAT'

Scientists in the United States of America have produced genetically modified pigs with fat containing omega-3 fatty acids. These fatty acids, which are usually found in salmon, mackerel and fresh tuna, are thought to be responsible for a number of benefits, from combating heart disease to improving intelligence.
Researchers from the University of Pittsburgh – School of Medicine created piglets capable of converting less useful omega-6 fatty acids into omega-3 fatty acids. They implanted 1 800 embryos into 14 female pigs. Ten live offspring, which were able to make high levels of omega-3 fatty acids, were born.
[Adapted from: Cape Argus, 27 March 2006]

(Read the passage through and underline what you think will be the important facts. Read the passage again, now answer the questions.)

1.1. Name TWO health benefits of omega-3 fatty acids. (2)

1.2. What percentage success did the scientists have with the implanted embryos in forming a clone of pigs capable of producing omega-3 fatty acids? Show ALL working. (3)
(Show each step of the calculation.)

1.3. To produce genetically modified pigs, the gene that produces omega-3 fatty acids is inserted into the pig embryos. Describe the steps in forming and introducing many copies of the desirable gene (using bacteria) into the pig embryos. (4)

1.4. Give TWO reasons why:

a) Some people may support the use of genetically modified pigs to produce omega-3 fatty acids. (2)

b) Some people may be against the use of genetically modified pigs to produce omega-3 fatty acids. (2)

[13]

Question 2: 12 minutes *(Taken from DoE November 2008 Paper 1)*
The diagram below shows the steps of an experiment in which a large number of genetically identical frogs were developed from unfertilised frog eggs. The nucleus of each unfertilised egg was destroyed and replaced by a nucleus obtained from a body cell from frog X.

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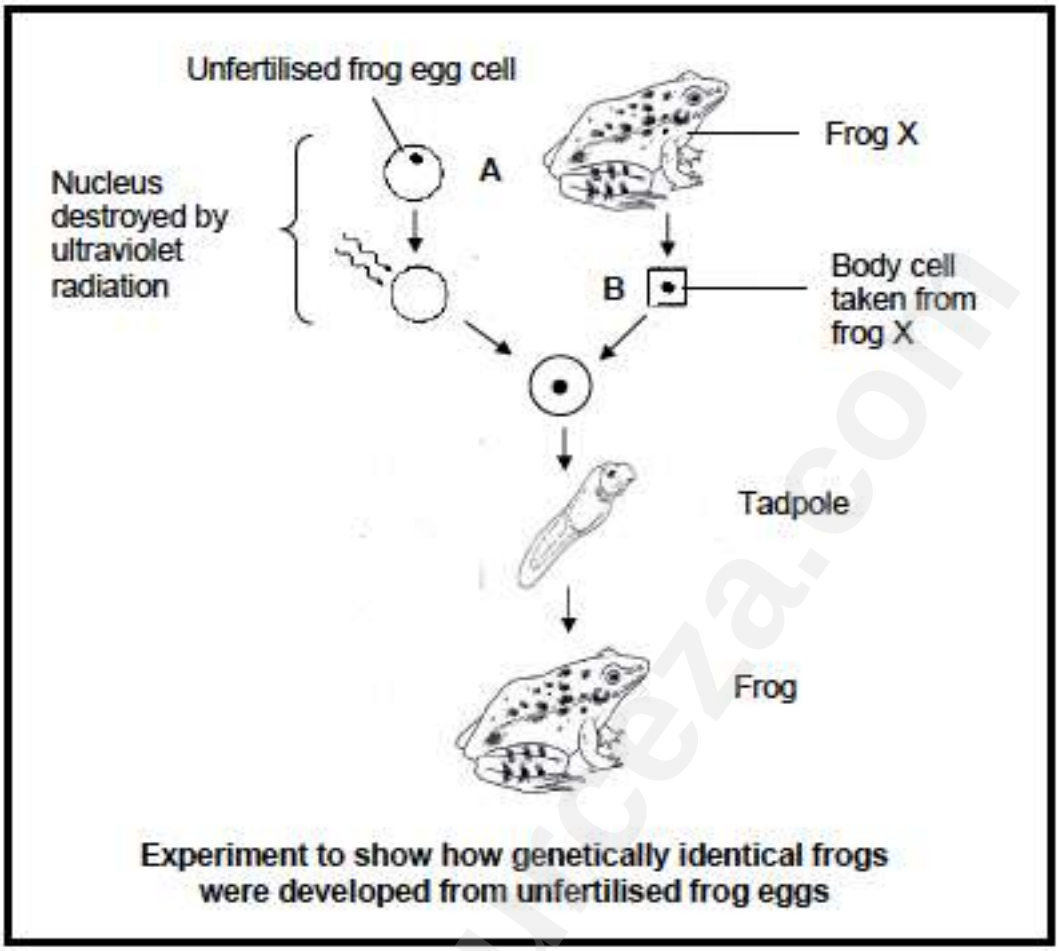
(Reminder: refer to the notes on cloning)



Experiment to show how genetically identical frogs were developed from unfertilised frog eggs

2.1. The diploid number of chromosomes in the above frogs is 26. How many chromosomes are present in the nucleus of the following cells?
(a) Cell A (1)
(b) Cell B (1)

2.2. Why can an egg containing a nucleus from the body cell of a frog develop into a tadpole? (2)

2.3. Explain why all the frogs produced from the treated eggs are genetically identical. (2)

2.4. Name the method of producing genetically identical offspring as shown in the diagram. (1)

2.5. State ONE reason why some people might:
(a) Favour the process shown in the diagram (2)
(b) Be against the process shown in the diagram (2)

[11]

Question 3: 10 Minutes (Own source)

A homozygous black rabbit with brown eyes is mated with a homozygous white rabbit with blue eyes. Black fur colour is dominant over white fur and brown eyes are dominant over blue eyes.

Show the genetic cross and indicate the genotypes of the F_1 generation. (8)

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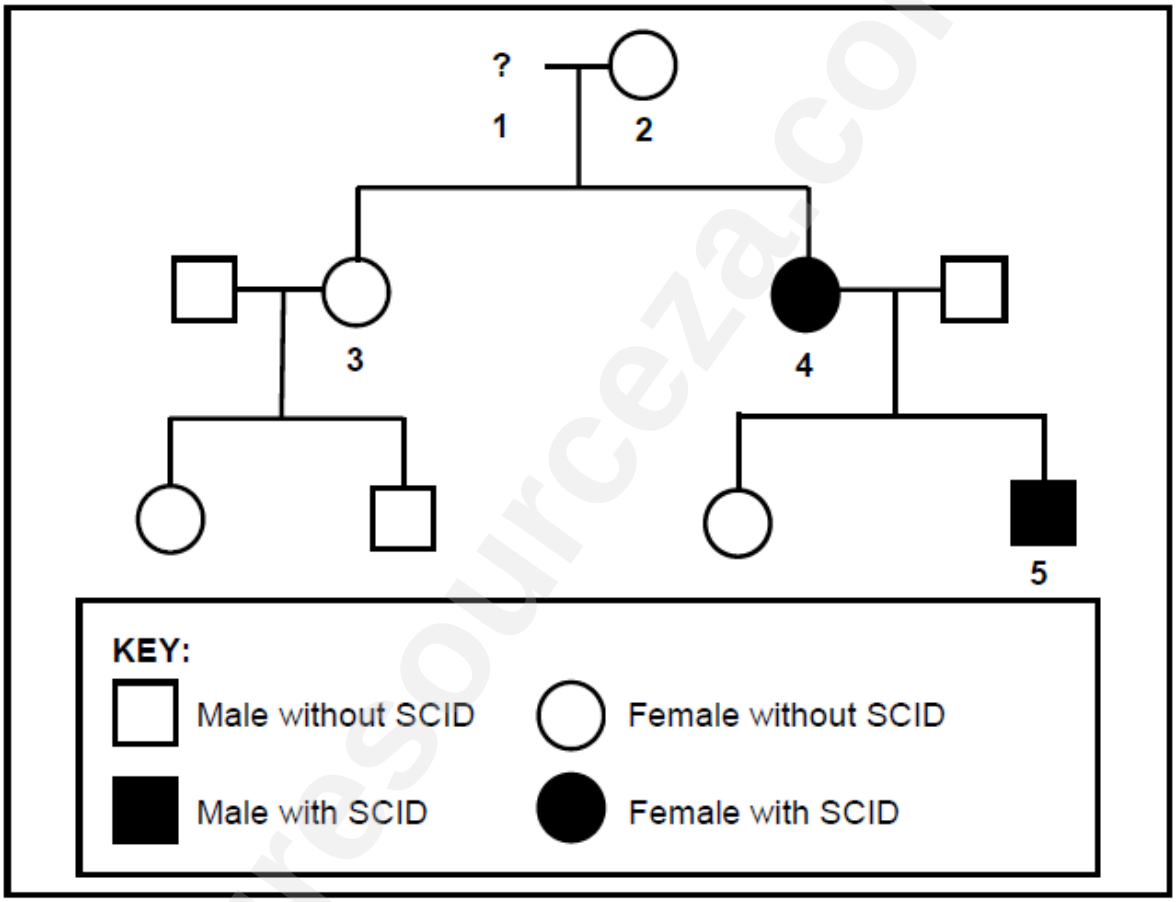
(Hint: Let B = Black fur, b = white fur, G = brown eyes and g = blue eyes. Homozygous black with homozygous brown eyes = BBGG and homozygous white with homozygous blue eyes = bbgg)

Question 4: 6 minutes *(Taken from DoE November 2018 Paper 2)*

Severe combined immune deficiency syndrome (SCID) is a disorder affecting the immune system. It is caused by a sex-linked recessive allele (X^d).

The diagram below shows the inheritance of the disorder in a family. It is not known if individual **1** has the disorder or not.



4.1 Give the:

(a) Phenotype of individual **2** (1)

(b) Phenotype of individual **1** (1)

(c) Genotype of individual **3** (2)

4.2 Explain how individual **5** inherited the disorder. (2)

(6)

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Question 5: 9 Minutes *(Taken from DoE November 2018 Paper 2)*

Read the extract below.

> The first cloned animal in Africa, a calf named Futhi, was born in North West in South Africa on 19 April 2003. No fertilisation was involved in the production of Futhi. She was produced from a single cell taken from the ear of a donor cow named LMJC 865. The donor cow had a high average milk yield of 78 litres a day. Cloning allows for the production of organisms with desired characteristics.
>
> Some people argue that cloning reduces genetic variation in the offspring, with no further genetic improvement. Cloning is an expensive procedure and may not be economical for commercial agriculture.

5.1 According to the extract, state ONE:
(a) Advantage of cloning (1)
(b) Disadvantage of cloning (1)
5.2 State why the donor cell was taken from LMJC 865 and not from any other cow. (1)
5.3 State why an ear cell was used and not an ovum. (2)
5.4 Briefly describe the process of *cloning*. (4)
(9)

Question 6: 12 minutes *(Taken from DoE November 2018 Paper 2)*

Flower colour (purple or white) in a particular plant species is controlled by two alleles, **D** and **d**.
Four crosses were carried out to determine which allele is dominant. Forty (40) offspring were produced in each cross. The phenotypes of the parents and offspring in each cross were recorded.

The results are shown in the table below.

CROSS	PHENOTYPE		
	PARENT 1	PARENT 2	OFFSPRING
1	purple	white	40 purple
2	purple	purple	31 purple, 9 white
3	white	white	40 white
4	purple	white	21 purple, 19 white

6.1 State the dominant flower colour. (1)
6.2 Use cross **1** to explain your answer to QUESTION 6.1. (2)
6.3 State Mendel's Law of Segregation. (3)
6.4 Use a genetic cross to show how the crossing of two purple flowering plants can produce white offspring, as in cross **2**. (6)
(12)

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SESSION NO: 5 Reproduction Part 1

Diversity of reproductive strategies in some animals

Different groups in the animal kingdom have developed reproductive strategies to ensure reproductive success and survival of the species.

In order for sexual reproduction to take place, two individuals (one male and one female) must come together so that fertilization can occur.

External versus internal fertilization:

- **External fertilization:** ovum and the sperm cell fuse **outside** of the female's body. Ova are generally inside the egg structures. The female lays her eggs and the male deposits his sperm cells **over** the eggs. Examples are frogs and many species of fish.

- **Internal fertilization:** ovum fuses with the sperm cell **inside** the female's body in her reproductive system. In some fish, most reptiles and all bird species, reproduction is internal but fertilization is cloacal because eggs are produced. In mammals, **copulation** takes place when the male **inserts the penis** (copulatory organ) into the vaginal cavity of the female. Fertilization takes place in the **fallopian tubes**.

Embryo Development: Once fertilization has taken place, the diploid zygote develops into an embryo. This development takes place in an **egg** or in the **uterus**.

- **Viviparous:** the embryo develops **inside the uterus**. A placenta nourishes the embryo. The female **gives birth** to **live** young when the **gestation period** is complete.

- **Oviparous: Eggs** with shells are **laid** outside the female's body into a nest and continue to develop, **hatching** when development is complete.

- **Ovoviviparous:** The fertilized eggs remain in the **oviduct** of the female. The eggs have **no shell** and embryo feeds off the yolk (no placenta). When development is complete, the female **gives birth** to **live** young.

- **Amniotic Egg:** the amniotic egg has a porous leathery or hard eggshell to prevent the egg from drying out. There are three membranes: the **amnion** (protects embryo during development), **chorion** (transfers nutrients from the albumen to the embryo) and **allantois** (respiration and for waste disposal from embryo).

  Examples: Insects – eggs are not amniotic; Fish and amphibians: eggs are jelly-like without a shell for external fertilization; Reptiles – amniotic eggs when oviparous: Birds: amniotic eggs

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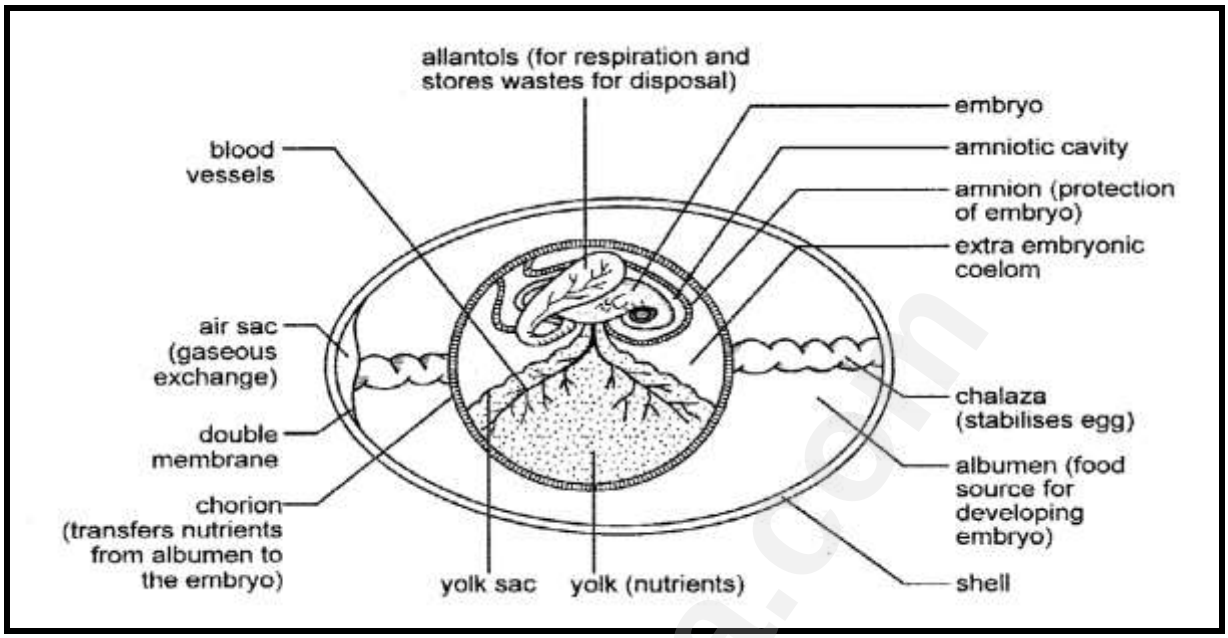

Amniotic Egg Diagram

- **Precocial and Altricial Development**
  - **Precocial:** young are mature and able to move directly after birth or hatching. They are able to fend for themselves and feed without parental care. The young have feathers and are able to fly. Eyes are open. **E.**g.: ducks, peacocks

  - **Altricial:** young are born helpless, cannot protect, feed themselves or fend for themselves. Young have downy feathers. Eyes are closed. **E.**g.: finches, swallows.

- **Parental Care:** Parents look after offspring to provide comfort, warmth, to feed and protect them. **E.g.**: Insects, fish, amphibians and Reptiles – no parental care. Precocial and altricial birds – parental care and mammals – long periods of protective nurturing where social behaviour and survival techniques are taught.

Different groups in the animal kingdom have different strategies to maximize reproductive success in different environments. These are a few of the strategies used by vertebrates.

Strategy	How it works?	What is its advantage?
External Fertilisation	The sperm fertilises the egg outside the body of the female, usually in water.	Water prevents the eggs from drying out and allows the sperm to swim towards the egg.
Internal Fertilisation	The male deposits its sperm inside the reproductive organs of the female and fertilisation occurs inside the female's reproductive organs	Allows terrestrial animals to reproduce in a dry environment without the need for water. Internal fertilisation is more certain than external fertilisation.
Ovipary	Eggs are laid and hatching takes place outside the mother's body	Egg provides nutrition for the developing embryo and protects

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		the embryo.
Vivipary	The young develop inside the uterus of the mother after the eggs are fertilised internally	More efficient development of the embryo as nutrients are received for a longer period from the mother's blood through a placenta. Embryo is protected in the body of the mother.
Ovovivipary	Young develop from eggs that are fertilised internally and retained within the mother's body after fertilisation	Embryos obtain their nutrients from the egg yolk. The eggs are protected from predators until hatching occurs.
Amniote Egg	Embryo protected by the shell of the egg; Egg consists of many membranes that serve different functions.	Amniote egg protects embryo from dehydration. Yolk sac provides nutrition, Allantois for excretion, chorion for gas exchange.
Precocial Development	Hatchlings are quite well-developed when they hatch – eyes open, able to move, able to feed.	Hatchlings are more prepared to handle the challenges of the environment; More independent.
Altricial Development	Hatchlings are poorly-developed when they hatch. Unable to feed on their own, cannot move.	Parental care afforded to protect the young from predators.
Parental Care	Parental care offered through building of nests, protecting the eggs, protecting the young, teaching the young.	Increases chances of survival of the young.

Questions

Question 1.1 (*Taken from various sources*)

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A to D) next to the question number (1.1 to 1.4).

1.1 The structure in the amniotic egg that supplies nutrients:

A Shell
B Allantois
C Chorion
D Yolk sac

1.2 The following is a list of functions performed by different organs in an organism:

(i) Protection
(ii) Gaseous exchange
(iii) Nutrition
(iv) Excretion

Which ONE of the following combinations refers to the functions performed by parts of an amniotic egg?

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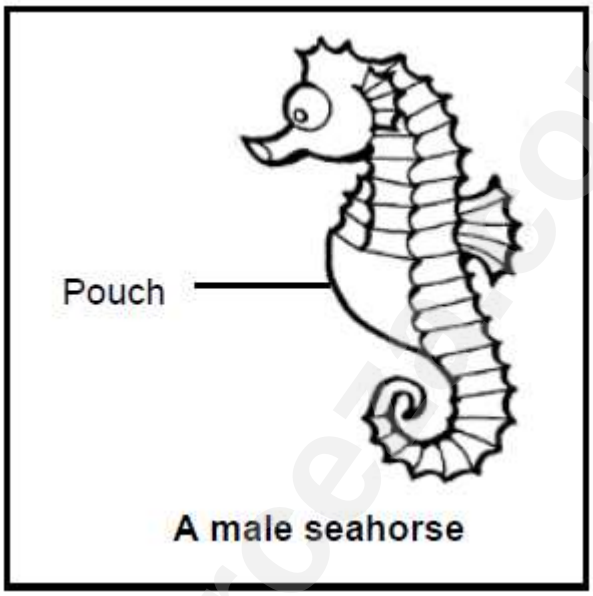
A (i), (ii) and (iii) only
B (i), (iii) and (iv) only
C (ii), (iii) and (iv) only
D (i), (ii), (iii) and (iv)

1.3 In seahorses the female deposits the eggs into a pouch in the male's body. The male then secretes sperm into the pouch. Fertilisation takes place in the pouch. The fertilised eggs develop in the pouch.



A male seahorse

What type of fertilisation and reproductive strategy does this represent?

A External fertilisation and vivipary

B Internal fertilisation and vivipary

C External fertilisation and ovipary

D Internal fertilisation and ovipary

1.4 Which ONE of the following is a characteristic of external fertilisation?

A Copulation takes place.
B A large number of eggs are produced.
C The embryo is protected in the female body.
D Sperm is introduced into the body of the female. (8)

QUESTION 1.2 (*Taken from various sources*)
Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.6).

1.2.1 A type of fertilisation in which the nucleus of a sperm fuses with the nucleus of an ovum outside the body of the female

The reproductive strategy when hatchlings are able to move and **(6)**

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1.2.2 feed themselves

1.2.3 A type of reproduction in humans where the foetus develops inside the uterus

1.2.4 The type of development in birds in which the young is capable of moving around on its own soon after hatching

1.2.5 The reproductive strategy where the development of the young takes place in the uterus of the mother

1.2.6 The reproductive strategy involving the laying of eggs

QUESTION 1.3 (*Taken from various sources*)
Indicate whether each of the statements 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 number (3.1 and 3.2).

COLUMN I		COLUMN II
1.3.1	A type of development in birds in which offspring are poorly developed at birth and are thus unable to feed themselves	A: Precocial development B: Altricial development
1.3.2	Requires the production of a large number of female gametes to ensure survival of the species	A: External fertilisation B: Internal fertilisation

(2 x 2) **(4)**

SESSION NO: 6 Reproduction Part 2

Terminology & Definitions

Afterbirth: The mass of placenta and membranes that are expelled from the uterus after the birth of a baby

Amnion: Fluid-filled sac where the embryo develops in the uterus

Amniotic fluid: Fluid surrounding the foetus in the amnion

Copulation: The insertion of the male reproductive organ into the female reproductive organ to transfer sperm to the egg cell

Corpus luteum: Structure that result when the Graafian follicle releases the egg cell during ovulation. The corpus luteum also secretes progesterone if the egg is fertilized

Cowper's gland: Secretes mucus that ensures greater motility of sperms cells

Epididymis: A long convoluted tube that stores sperm cells while they mature and reabsorbs them after four weeks if they are not

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ejaculated.

Fallopian tube: (Also called the oviduct): a muscular tube, lined with a mucus secreting ciliated epithelium joining each ovary to the uterus. Fertilization takes place in this tube.

Fertilization: Fusion of the nuclei of two haploid gametes (sperm cell and ovum) to form a diploid zygote

Follicle stimulating hormone: (FSH) Produced by the anterior lobe of the pituitary gland and causes the maturing of the follicle surrounding the oocyte and stimulates the supply of nutrients

Gametogenesis: It is the process to produce **haploid gametes** by meiosis. When sperm are produced, the process is called **spermatogenesis** and when female gametes are produced, it is called **oogenesis**. Both processes occur in the germinal epithelium of the gonads.

Implantation: When the blastula attaches to the lining of the uterus after about six days after fertilization has taken place

Internal fertilization: Fertilization that occurs inside the body of the female, inside the Fallopian tube

Luteinising hormone (LH): A hormone produced by the anterior lobe of the pituitary gland that stimulates the Graafian follicle to cause ovulation.

Menstrual cycle: This cycle begins with menstruation and continues for 28 days. It is controlled by hormones to co-ordinate the release of the mature egg cell with the readiness of the uterus for implantation, if fertilization takes place

Menstruation: When there is no fertilization, the lining of the uterus is shed to prepare for the next cycle. This results in a flow of blood that lasts for approximately 5 days

Oestrogen: A hormone secreted by the ovaries to bring about female secondary characteristics. It also causes the thickening of the endometrial lining in the uterus.

Oogenesis: The process to produce haploid egg cells in the follicles of the ovary

Ovaries: Female reproductive organs which release egg cells.

Placenta: It is the connection between maternal and embryonic villi in the uterus.

Pregnancy: It is the development of the embryo inside the uterus. It can also be called gestation.

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Progesterone: A hormone secreted by the corpus luteum when the egg cell is fertilized to maintain pregnancy

Prostate gland: Gland of the male reproductive system situated just below the urinary bladder. It secretes alkaline fluid to neutralise acidity in vagina

Seminal vesicle: A gland that produces a nutrient rich fluid responsible for nourishment of sperm cells.

Sperm: **Sperm** are very small cells of about 2,5 µm in diameter and 50 µm long. Each sperm cell consists of a head with a nucleus, a short neck and a long tail. The tail assists with swimming and orientating the sperm when they cluster around an egg.

Spermatogenesis: Diploid cells in the seminiferous tubule of the testes undergo meiosis to form haploid sperm cells

Umbilical cord: Links the placenta to the developing foetus. Consists of two umbilical arteries and one umbilical vein.

Urogenital system: The male reproductive system and the urinary system link so that both semen and urine pass out of the body through the urethra.

Vas deferens: The tube that carries sperm cells and seminal fluid into the penis during ejaculation

Vasodilation: It is the increase of blood volume causing the penis to become erect.
The erect penal tissue closes the valve of the urethra to prevent the possibility of urination during ejaculation of the sperm cells.

Male reproductive system:

The male reproductive system is closely related to the urinary system. Together, the two systems are called the **urogenital system**.

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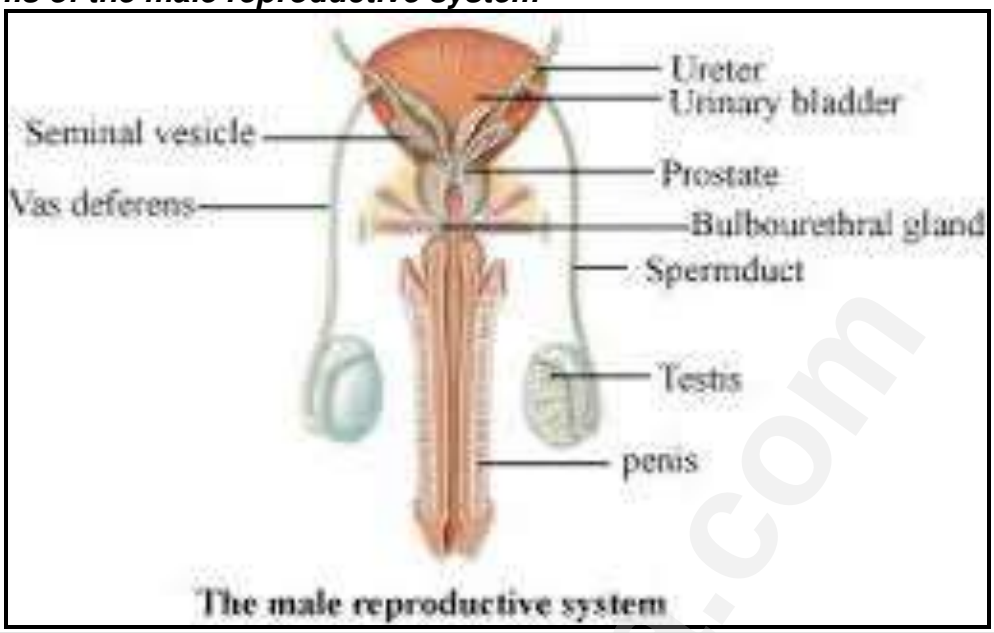
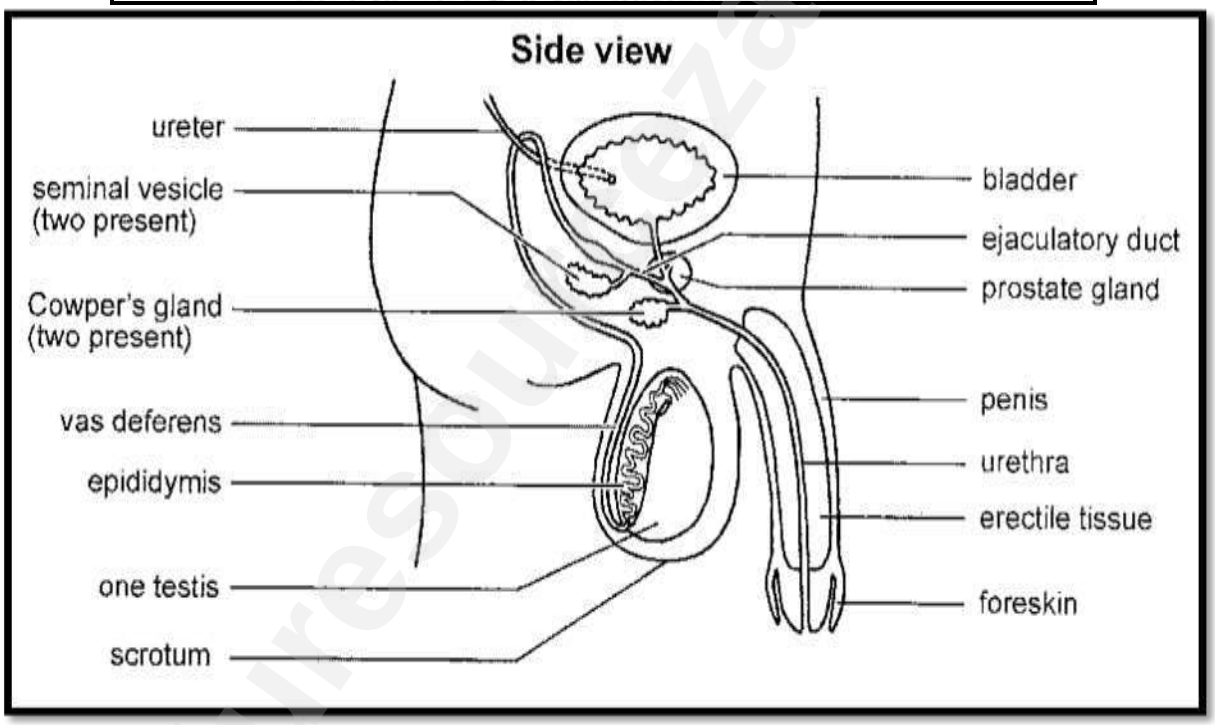
Diagrams of the male reproductive system





Structure	Function
Two glandular testes	Responsible for the production of the sperm and the male sex hormone called testosterone Testosterone is responsible for: • the secondary sexual characteristics when the males mature like a deeper voice, pubic hair and facial hair. • rapid physical growth at puberty • the maturation of reproductive organs and production of sperm
Scrotal Sac (bag	Holds the testis and hangs outside of the abdominal cavity to

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Structure	Function
of skin)	regulate the temperature of the testes at 35 °C. The scrotal sac can contract into the body when it is cold or relax and hang away from the body if the temperature is high.
Seminiferous tubules	Each testis consists of about a thousand coiled seminiferous tubules lined with germinal epithelium. It contains the **Leydig cells,** the **spermatogonia** and cells of **Sertoli**
Diploid spermatogonia	Undergoes spermatogenesis - produces haploid spermatozoa/sperm cells
Epididymis (6m long coiled tube)	Tube stores about 5000 million sperm per cm^3 until the sperm mature and are able to swim
Vas deferens	Tube that connects each testis from the epididymis to the urethra, just after the urethra leaves the bladder
Seminal vesicle (a short glandular tube)	Gland that secretes fructose which is an energy source for the sperm during ejaculation
Prostate gland	Secretes mucus mixed with a slightly alkaline fluid during ejaculation to increase motility of the sperm cells and neutralizes the possible acidity of the vagina
Cowper's gland	Secretes mucus to stimulate motility of sperm cells
Penis (consists of masses of erectile tissue that surrounds the urethra)	During sexual stimulation, blood flows into the erectile tissue causing the penis to become erect for insertion into the vagina during sexual intercourse. Semen (sperm and fluid) is ejaculated directly into the vagina (internal fertilization)

Female reproductive system:

Unlike the male urogenital system, the female has separate external openings for excretion and reproduction.

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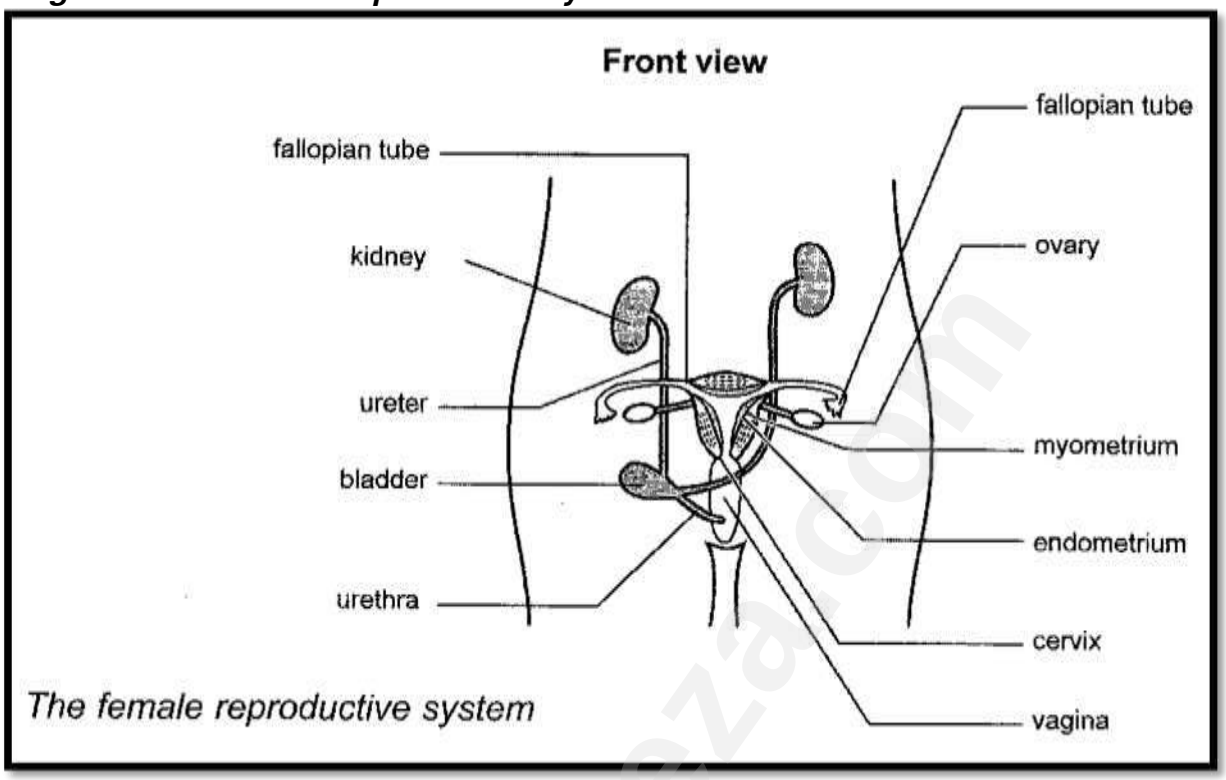
Diagram of the female reproductive system



Structure	Function
Ovaries (two almond-shaped ovaries are located inside the abdominal cavity)	The germinal epithelium produces the ova. Produce the sex hormones **oestrogen and progesterone**. Once female matures sexually, an ovum is produced each month and released during ovulation.
Fallopian tubes (a tube that connects the ovaries to the uterus)	Ovum moves along the fallopian tube to the uterus. Fertilization and the first stages of mitosis take place in the fallopian tube.
Uterus (a hollow, muscular, pear-shaped structure about 7,5 cm long and 5 cm wide, located inside the pelvic cavity behind the bladder)	**Endometrium:** inner layer consists of glands and a very good blood supply to provide nutrition and protection for developing foetus in pregnancy. Layer breaks away during menstruation.
Cervix	Opening between the Vagina and uterus. A mucus plug develops in the cervix during pregnancy.

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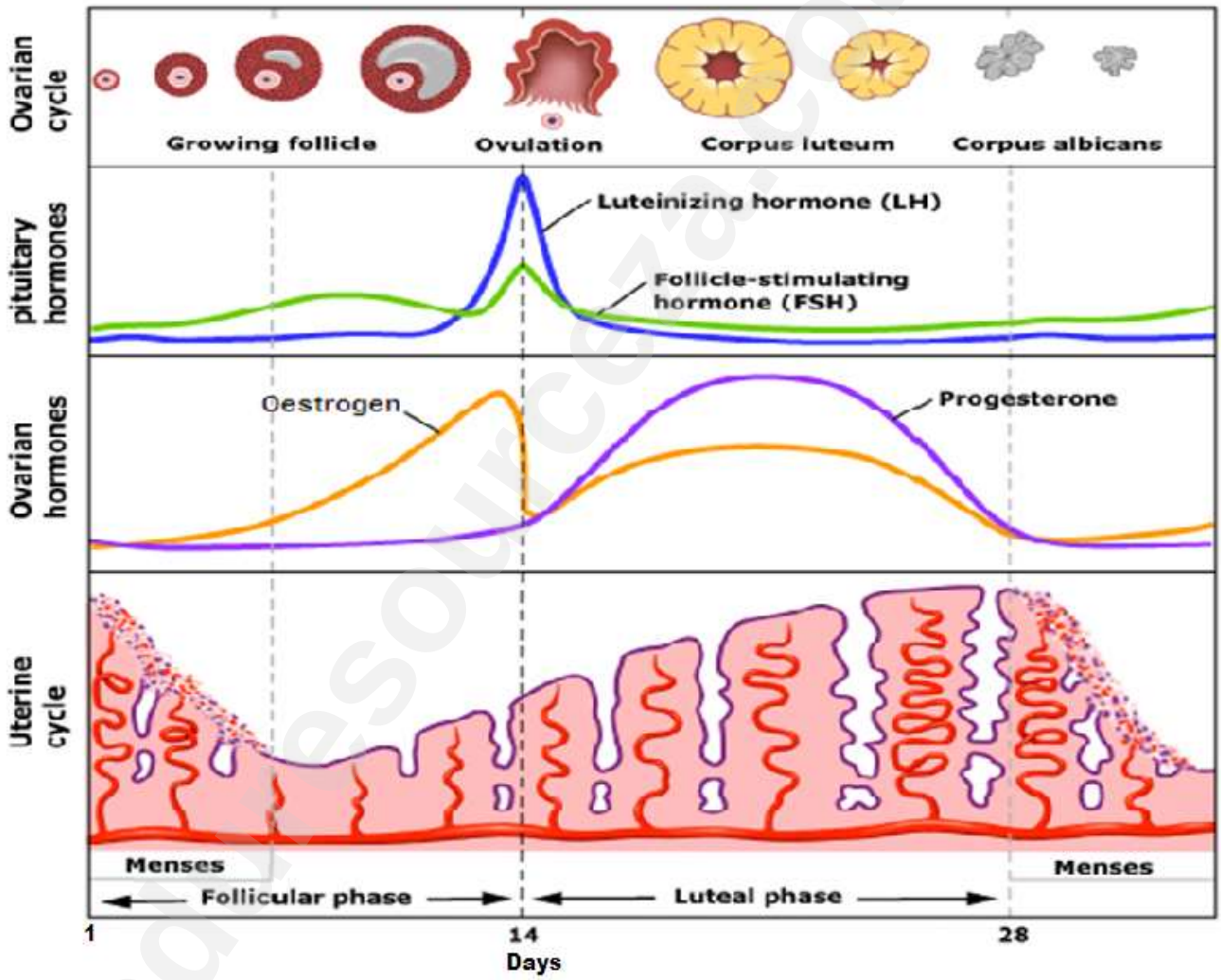
Structure	Function
Vagina (a muscular tube 8 to 10 cm long, with elastic tissue and a folded lining, connecting the external area with the uterus and has an exterior opening called the vulva.	Links from the outside to the uterus. Able to stretch when penis is inserted during copulation and childbirth process because it forms the birth canal.

Hormonal control of oogenesis



- Hormones are released to control the **menstruation cycle**, which lasts about **28 days** in females. Usually only one ovum is released per cycle. The menstruation cycle affects both the ovaries and the uterus at the same time.

- **FSH** is secreted by the pituitary gland and transported via the bloodstream to the ovaries where it stimulates the **development of the follicle**.

- The developing follicle produces oestrogen, which has two target organs namely the uterus and the anterior pituitary gland. **Oestrogen** will increase the thickness

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of the **endometrium** in the uterus. This is to prepare the uterus for pregnancy because the embryo will implant into the endometrium.

- Oestrogen **inhibits** the secretion of FSH by the anterior pituitary gland so that no further follicles are produced. This is why only one ovum is produced at a time. High oestrogen levels will trigger the secretion of **luteinising hormone (LH)**.

- **LH** is released into the blood and is transported to the target organ, the Graafian follicle in the ovary and causes **ovulation**. Ovulation is the release of the **secondary oocyte** from the Graafian follicle. Each month one ovum is released from one ovary at a time. LH stimulates the 'empty' Graafian follicle to develop into the corpus luteum.

- The **corpus luteum** continues to secrete oestrogen and progesterone. Progesterone has two target organs, namely the uterus and the anterior pituitary gland. In the uterus, thickening of the endometrium is maintained and glandular activity is stimulated. Progesterone **inhibits** the release of **LH** and **oestrogen.** The release of progesterone causes the slight rise in temperature just after a female has ovulated.

- Should **fertilisation not take place**, the corpus luteum **degenerates**, causing the levels of **oestrogen** and **progesterone** to **decrease**. The endometrium starts to break down and **tear away** from the walls of the uterus, causing the bleeding associated with **menstruation**. This phase lasts for about **five days**.

Copulation

Terrestrial organisms generally reproduce by **internal fertilisation**. The process of inserting the sperm cells into the vagina of the female is called **copulation**.

Fertilisation and Development of zygote to blastocyst

The process of fertilisation is when the haploid nucleus of the ovum and the haploid nucleus of the sperm cell fuse to form a diploid zygote.
When the head of the mature sperm cell comes into contact with the membrane of the ovum, enzymes are released from the **acrosome** of the sperm to dissolve the membrane of the ovum. Only the head of the sperm enter the ovum. The middle piece and tail are discarded, as it is no longer required. The ovum immediately forms a **fertilisation membrane** around itself. This prevents any other sperm cells from entering it. Fertilisation occurs inside the **fallopian tube.**
The diploid zygote contains 46 chromosomes in the nucleus (23 from the sperm cell and 23 from the ovum). After fertilisation, the zygote is moved by muscle contractions in the fallopian tube and pushed towards the uterus. This takes about three days.
The zygote undergoes **mitosis** and divides to form a **solid ball of cells** called the **morula**. The morula develops into a **hollow ball of cells** called a **blastula**. The outer membrane of the blastula develops finger-like outgrowths called **chronionic villi** that grow into the **endometrium.** These outgrowths anchor the developing embryo and increase the surface area for the absorption of nutrients.
The blastula attaches to the endometrium of the uterus after about six days and this is called **implantation**.

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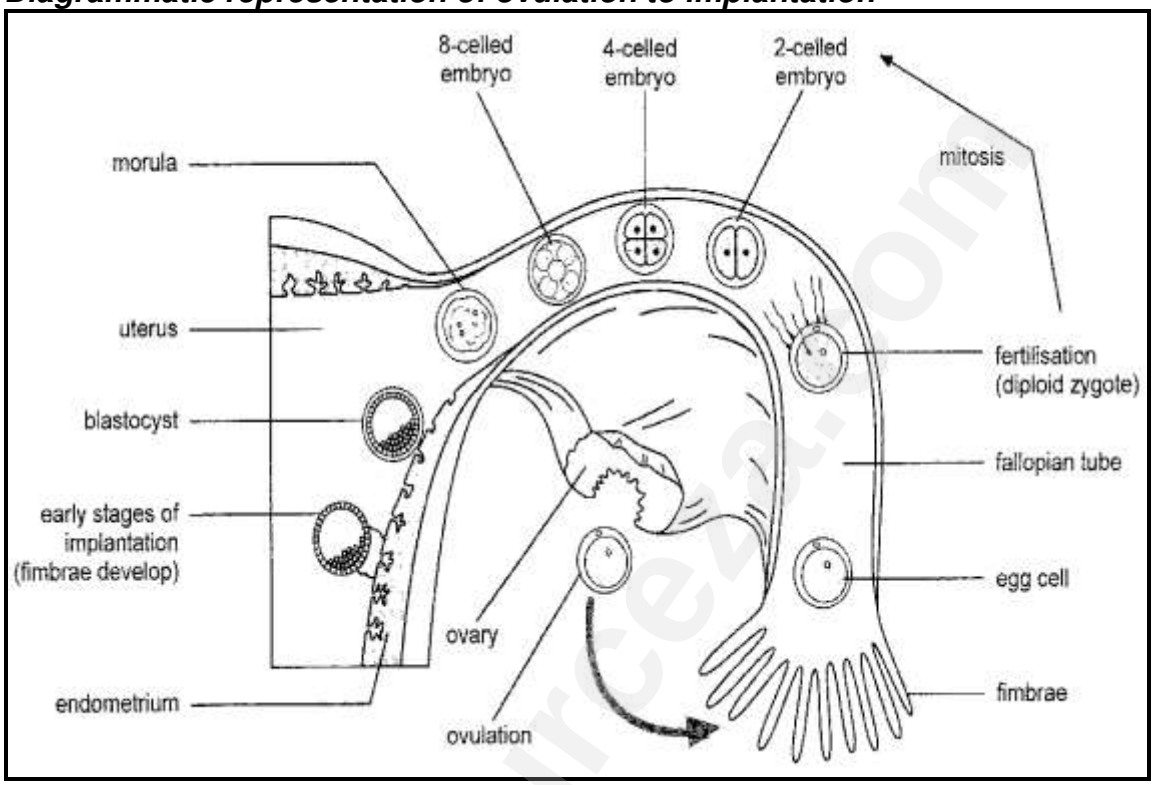
Progesterone (secreted by the placenta after 12 weeks) and **oestrogen(** secreted by the ovaries**)** increase the thickness of the endometrium to maintain pregnancy and prevent miscarriage .The embryo will develop into a **foetus** where, after 40 weeks of development, the baby will be born to ensure the continuation of the species.

Diagrammatic representation of ovulation to implantation



Gestation

Gestation (pregnancy) means the development of the embryo (after 12 weeks it is called a foetus) inside the uterus over a period of 40 weeks.

Development of the placenta and amnion

The placenta is a combination of cells from the foetus and the mother, which develops from about 12 weeks of pregnancy. It allows for the exchange of a number of substances. The **umbilical cord** attaches the foetus to the placenta.

- **Nutrients, oxygen and hormones** diffuse from maternal blood into foetal blood and are transported to the foetus by the **umbilical vein**.
- **Carbon dioxide and nitrogenous wastes** diffuse from foetal blood into maternal blood via the two **umbilical arteries** so that it can be excreted.
- **Antibodies** from maternal blood ensure passive immunity against diseases.

The placenta ensures that there is no direct link between the mother's blood and that of the developing foetus.

The **amnion** is a membrane that develops around the embryo. The amnion fills with **amniotic fluid**, which **protects the embryo** by cushioning it and also **regulates the embryo's body temperature**.

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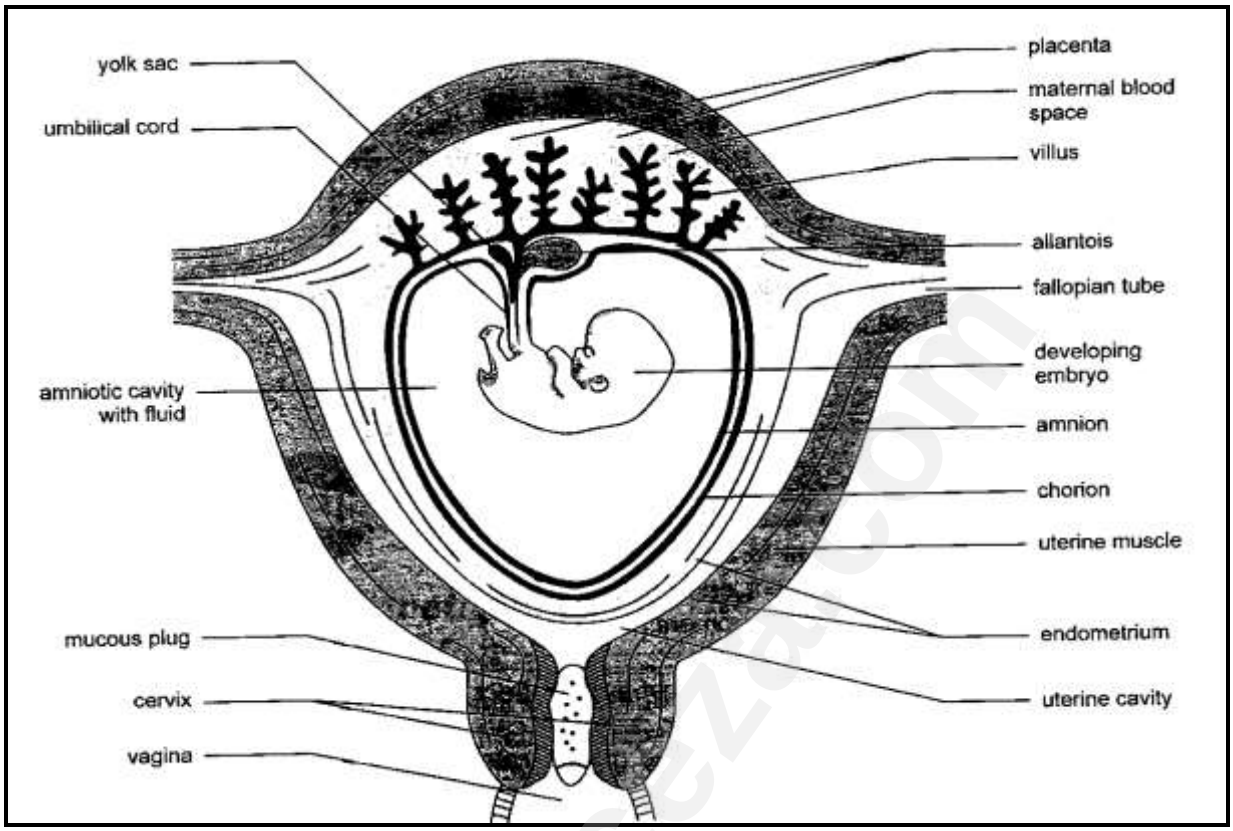


Birth

The process of birth is called **parturition**. It occurs in **three stages**:

Labour: The walls of the uterus begin to contract, indicating the onset of labour. The uterine contractions cause the amnion to burst and the amniotic fluid is released and the cervix dilates.

Expulsion: The uterine contractions force the baby down through the pelvic bones and through the vagina (birth canal). The **umbilical cord** connecting the baby to the placenta is cut and tied off.

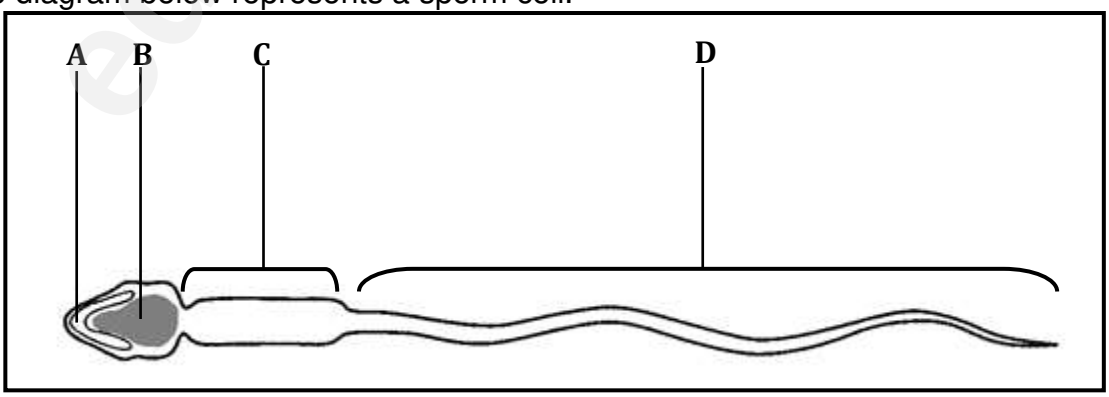
Afterbirth: The mother will undergo more contractions to expel the placenta. The placenta is now called the **afterbirth**.

Note: the umbilical cord has a very good supply of **stem cells**.

Questions

QUESTION 1 (*Taken from DBE, ASC June 2016,Paper 1)*

The diagram below represents a sperm cell.



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1.1 Identify part:
(a) **B** (1)
(b) **D** (1)

1.2 Explain ONE way in which the sperm cell is adapted to ensure effective movement towards the Fallopian tubes. (2)

1.3 Explain the consequences for reproduction if a sperm cell did not have part **A**. (3) **(7)**

QUESTION 2 (*Taken from DBE, ASC June 2016,Paper 1)*
Research shows that the average age of first menstruation is influenced by socio-economic status as well as race.
Scientists carried out an investigation to determine the average age of the first menstruation of the girls in a community.
Their hypothesis was:
The average age of first menstruation has decreased over time.

2.1 For the investigation, state the:

(a) Independent variable (1)

(b) Dependent variable (1)

2.2 Name THREE planning steps that had to be considered before carrying out the investigation. (3)

2.3 If the results show that the average age of first menstruation has remained at 12,9 years of age for the last 25 years, explain the implications for the hypothesis stated by the scientists. (2)

2.4 Name TWO physical characteristics in girls which would indicate the start of puberty. (2) **(9)**

QUESTION 3 (*Taken from DBE, ASC June 2016,Paper 1)*
One contraceptive method for females is to take a daily oral pill that contains progesterone.
Explain how this pill functions to prevent pregnancy. **(4)**

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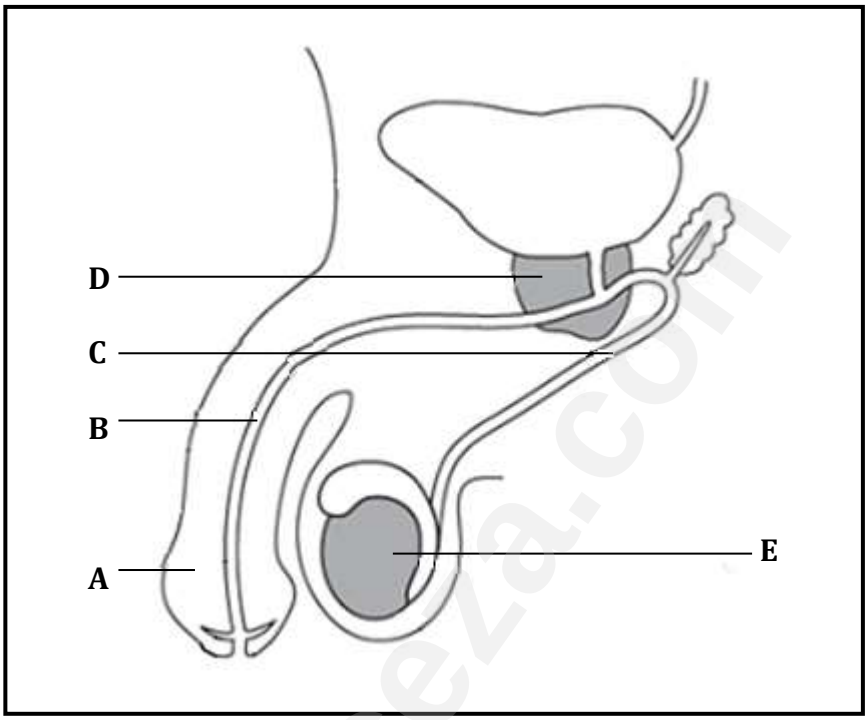
QUESTION 4 (*Taken from DBE, Feb 2016,Paper 1)*
The diagram below represents a part of the male reproductive system.



4.1 Give the LETTER and the NAME of the part that:
(a) Is used in copulation (2)
(b) Produces testosterone (2)

4.2 Give ONLY the LETTERS of the TWO parts in the diagram that:

(a) Contribute to the formation of semen (2)
(b) Provide a passage for the sperm cells (2)
(8)

QUESTION 5 (*Taken from DBE, Feb 2016,Paper 1)*
An investigation was conducted to determine the relationship between the ages of women, the number of pregnancies per month and the chances of miscarriages.
The results of the investigation are shown in the table below.

AGES OF WOMEN	PREGNANCIES PER MONTH (%)	MISCARRIAGES (%)
22	25	10
28	24	11
34	18	15
40	6	24
46	2	50

[Adapted from http://www.children.gov.on.ca]

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5.1	Draw a line graph to show the relationship between the ages of the women and the percentage of pregnancies per month.	(6)
5.2	Describe the relationship that exists between the ages of women and the chances of them miscarrying.	(2)
5.3	According to the data obtained, if there are 12 pregnant women who are 46 years old, how many of them are likely to miscarry? Show ALL working.	(2) **(10)**

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