

SENIOR SECONDARY INTERVENTION PROGRAMME 2013



education

Department: Education

GAUTENG PROVINCE

GRADE 12

LIFE SCIENCES

LEARNER NOTES

The SSIP is supported by



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LEARNER NOTES

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SESSION 1: TOPIC 1: NUCLEIC ACIDS – DNA AND RNA



Learner Note: Please ensure that you understand that the nucleus is an organelle located in a cell. Go through the structure of DNA and RNA very carefully. You **MUST** understand the structure and combination of the complimentary bases or you will not be able to answer exam questions based on Protein Synthesis. REMEMBER: **Thymine** is only **in DNA** and **Uracil** is only **in RNA**.

SECTION A: TYPICAL EXAM QUESTIONS

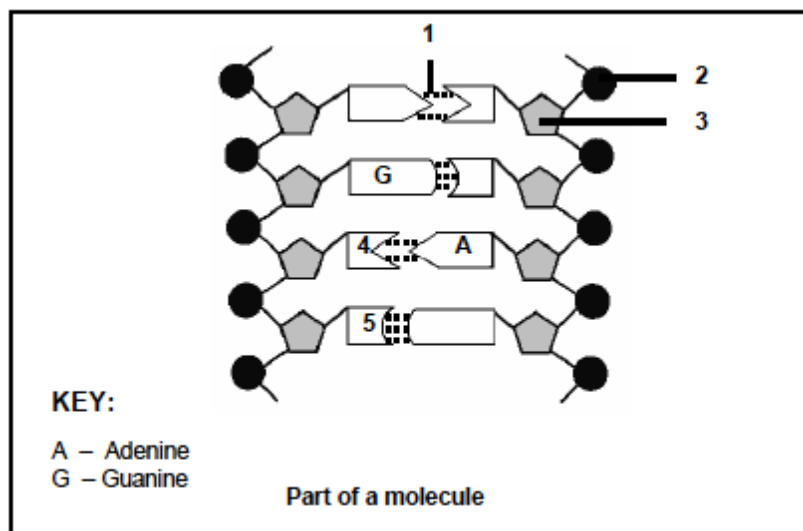
QUESTION 1: 16 minutes

(Taken from DoE Exemplar 2008)

HINTS:

The structure of the DNA and RNA molecule is very important and is often examined. Make sure that you know the labels of each component. Remember to label the diagram first and then move onto the questions

1.1 The diagram below represents a part of a molecule. Study the diagram and answer the questions that follow.



- 1.1.1 Identify the molecule in the above diagram. (1)
- 1.1.2 Label the parts numbered 1 and 5 respectively. (2)
- 1.1.3 What is the collective name for the parts numbered 2, 3 and 4? (1)
- 1.1.4 What is the significance of this molecule being able to replicate itself? (2)
(Replicate means to make another identical molecule – to ‘copy’)

1.2 The following questions are based on protein synthesis.

1.2.1 Describe each of the following: (***You must learn the definitions.***)

(a) Transcription (2)

(b) Translation (2)

1.2.2 The diagram below shows the sequence of nitrogenous bases of a strand of DNA which codes for part of a protein molecule.

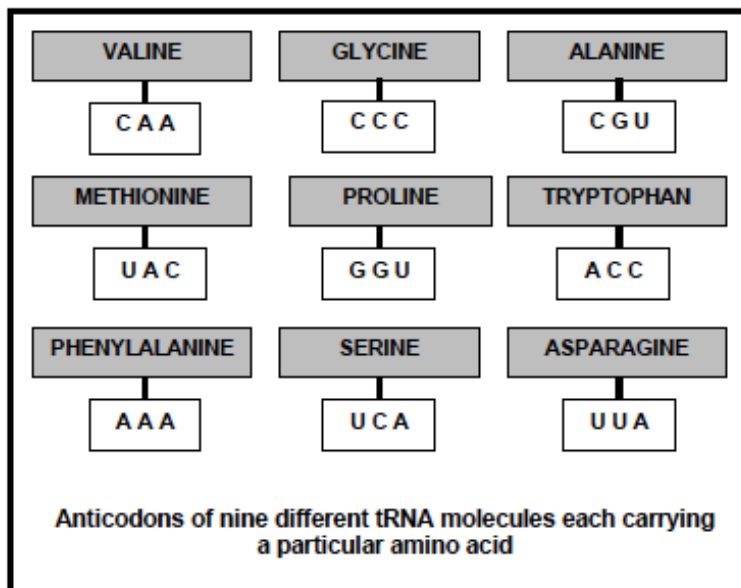
GTT — ATG — TGG

Write down the mRNA codon sequence that reads from left to right from the DNA sequence above. (3)

(Remember that the mRNA codon will always be opposite to the DNA code. Also remember that Thymine is only found on DNA and that on RNA Thymine is replaced with Uracil)

1.2.3 The following diagram shows the anticodons of nine different tRNA (transfer RNA) molecules each carrying a particular amino acid.

(The anti-codon is the opposite to the mRNA and is, therefore, the same as what was coded on the DNA)



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

UUU — GUU — AUG

(3)
[16]

QUESTION 2: 8minutes*(Taken from DoE November 2009)*

The table below shows the DNA base triplets that code for different amino acids.

Amino acid	Base triplet in DNA template
Leu (leucine)	GAA
His (histidine)	GTA
Lys (lysine)	TTT
Pro (proline)	GGG
Ala (alanine)	CGA
Trp (tryptophan)	ACC
Phe (phenylalanine)	AAA
Gly (glycine)	CCT

The following is a part of a sequence of amino acids that form a particular protein molecule:

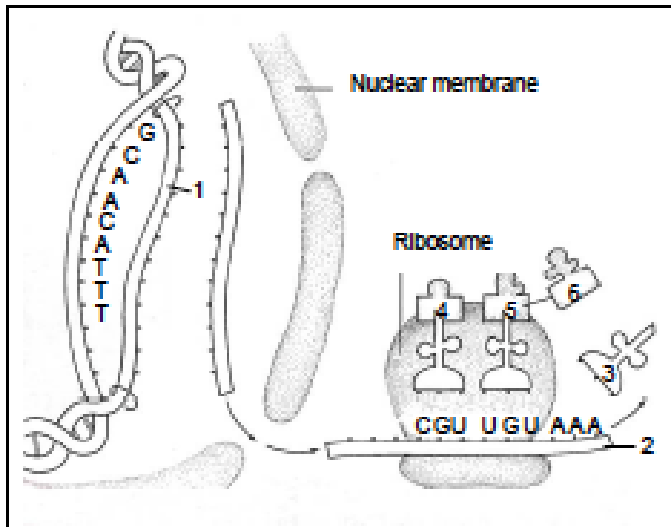
(A reminder that a codon is made up of 3 bases and can also be called a triplet base)

Ala	His	Trp	Leu	Lys
-----	-----	-----	-----	-----

- 2.1 Name the process by which mRNA is formed from a DNA template. (1)
 - 2.2 How many mRNA codons would be involved in forming the portion of protein shown above? (1)
 - 2.3 Write down the sequence of the first THREE mRNA codons (from left to right) for this portion of the protein. (3)
 - 2.4 The following is a sequence of base triplets in DNA: **GAA - GTA - TTT - AAA**
 - (a) If guanine, found in the first base triplet, is removed, explain how this would affect the structure of the protein. (2)
 - (b) Name the process that occurs when the sequence of bases in DNA changes. (1)
- [8]

QUESTION 3: 11 minutes*(Taken from DoE Preparatory Exam 2008)***(A reminder first to label the diagram and then to move on to questions)**

Study the diagram illustrating protein synthesis below, and answer the questions that follow.



3.1 Label the molecules indicated by 2 and 3. (2)

3.2 Using the letters of the genetic code, write down the complementary nitrogenous bases on strand 1 of the DNA double helix, starting from the top. (3)
(Remember: A=T/U and G=C)

3.3 Use the table below to determine which three amino acids in the diagram are represented by 4, 5 and 6. (3 x 2) (6)

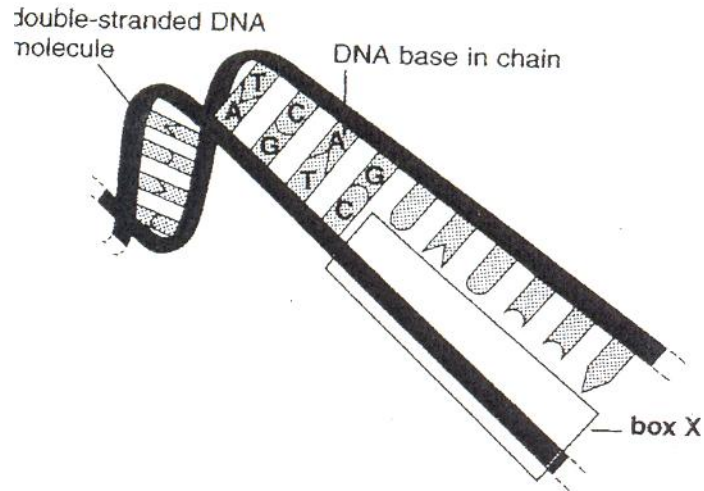
THE RELATIONSHIP BETWEEN tRNA AND AMINO ACIDS DURING PROTEIN SYNTHESIS	
tRNA anticodons	Amino acid
UGU	threoline
CGU	alanine
UUU	lysine
ACA	cysteine
GCA	arginine
GUU	glutamine
CUA	aspartate
CCA	glycine
AAA	phenylalanine

[11]

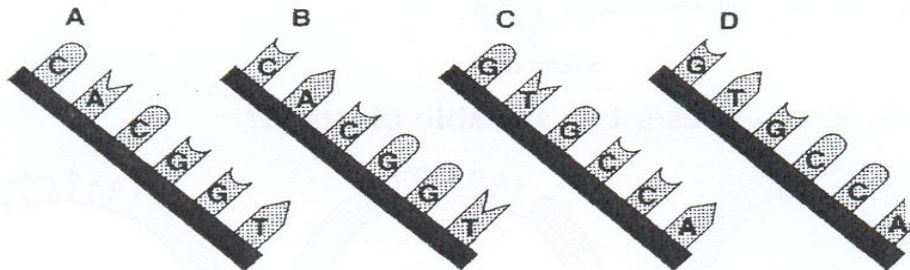
QUESTION 4: 5 minutes

(4.1 to 4.3 taken from Bishops Prelim 2008 and 4.4 to 4.5 taken from FS DoE prelim 2008)

- 4.1 The first of the accompanying diagrams shows a small part of the DNA molecule where the four types of base molecules are represented by the letters A, T, C and G.



Which of the following supplies the information missing from Box X in the first diagram?

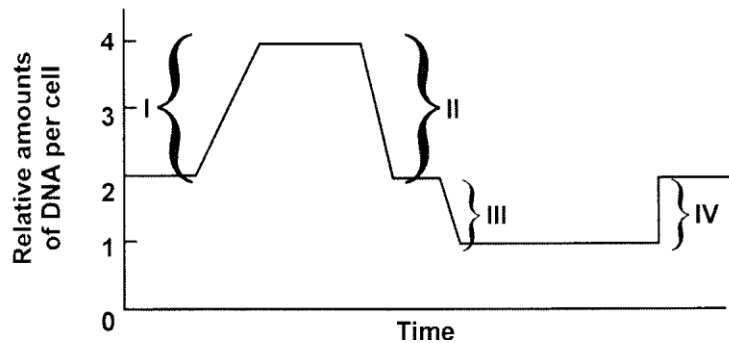


- 4.2

Sally carries the gene pairs AA, Bb and Dd on different chromosome pairs. Which one of her egg cells could contain the following genes:

- A abd?
- B ABDd?
- C AbD?
- D AA Bb Dd?

- 4.3 The graph below shows changes in the amount of DNA per cell in a series of cellular events in a mammal.



Which one of the following combinations correctly describes the events shown on the graph?

	I	II	III	IV
A	DNA Replication	Mitosis	Meiosis	Fertilisation
B	DNA Replication	Meiosis 1	Meiosis 2	Fertilisation
C	Fertilisation	Meiosis	Mitosis	DNA Replication
D	Mitosis	Meiosis 1	Meiosis 2	DNA Replication

- 4.4 In analysing the number of different bases in a DNA sample, the following result would be consistent with the base-pairing rules:

- A. $A = G$
- B. $A + G = C + T$
- C. $A + T = G + C$
- D. $A = C$

- 4.5. Which component is NOT directly involved in translation?

- A. mRNA
- B. DNA
- C. tRNA
- D. ribosomes

(1 x 5) [5]

SECTION B: ADDITIONAL CONTENT NOTES**1. Introduction:**

The nucleus controls all life processes within a cell and is responsible for hereditary information. This information is encrypted on the genes that are found on the chromosomes. Each chromosome contains DNA (deoxyribose nucleic acid). RNA (Ribose nucleic acid) is found within the nucleus and also the cell cytoplasm. Genetic information makes each organism unique.

Functions of the nucleus

- Controls cell metabolism
- Responsible for cell division
- Controls protein synthesis
- Controls the production of RNA
- **Responsible for the transfer of hereditary characteristics.**

2. Nucleic acids

Nucleic acids are responsible for the **control and transfer** of hereditary characteristics and the structure of proteins that are produced during protein synthesis. Each individual organism consists of proteins that are unique to only that organism. This is why organs are not simply transplanted from one organism to another. If the proteins are not similar, then the body will reject the organ. This is why organ transplants show the most success between siblings (brothers and sisters). The closest a parent can be to their offspring is 50% because each offspring is a combination of 50% male parent and 50% female parent.

There are two types of nucleic acids.

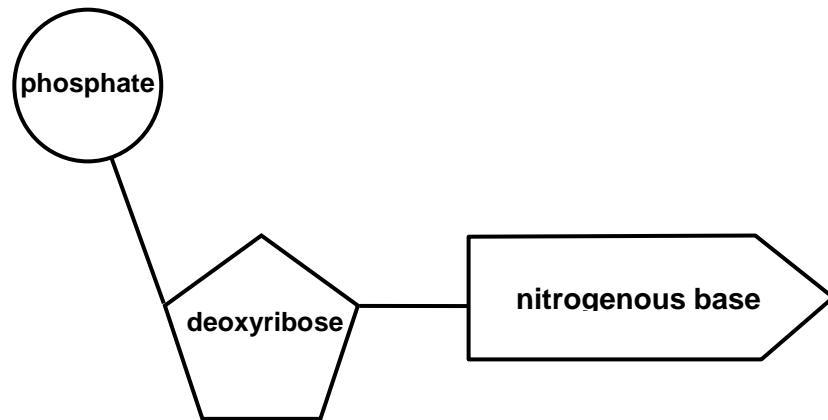
- **DNA** - deoxyribose nucleic acid and
- **RNA** - ribose nucleic acid.

DNA is found in the threadlike **chromosomes** and RNA is found mainly in the **nucleolus** and the **cytoplasm**. DNA strands contain active sections called **genes**.

2.1. Structure

Each nucleic acid consists of a number of basic building blocks called nucleotides. Each nucleotide consists of three parts:

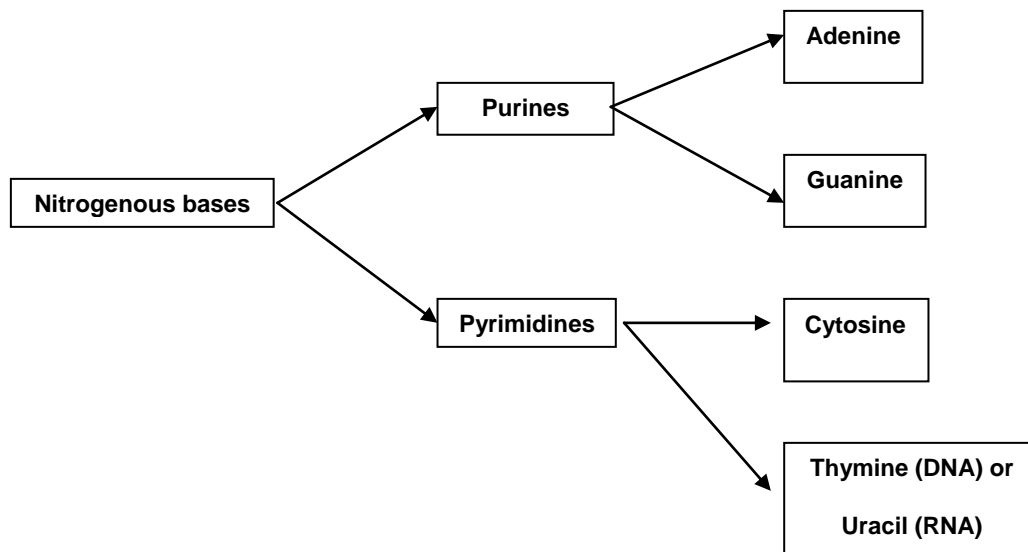
- 1 phosphate ion
- 1 pentose sugar
- 1 nitrogenous base



Nitrogenous bases are divided into two complementary groups:

- **Purines:**
- **Pyrimidines:**

DNA forms a **double strand** where purines will **only bond** with pyrimidines. DNA contains **Thymine** and RNA contains **Uracil** instead of thymine. The other nitrogenous bases are found in both DNA and RNA.



A back bone of **phosphates** and **pentose sugars** join to the nitrogenous bases, resulting in a long chain. The nitrogenous bases are attached to each of the pentose sugars.

2.2. The DNA molecule

The DNA molecule is a double helix (twisted) strand. The four nitrogenous bases can be arranged in any order with a purine attached to a pyrimidine. The combination of nitrogenous bases is the code system for the messages from the DNA. A weak hydrogen bond holds the complementary nitrogenous bases together. This occurs as follows:

- **Adenine always only joins to Thymine**
- **Guanine always only joins to Cytosine**

2.3. The RNA molecule

The RNA molecule is always a single strand of nucleotides and contains a single row of purines attached to pyrimidines. Remember that the RNA contains Uracil instead of Thymine. RNA is responsible for protein synthesis.

There are three types of RNA, each with a specific function:

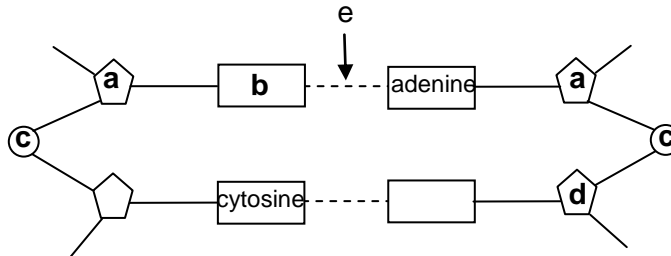
- Messenger RNA (mRNA): mRNA is formed by the DNA as a piece of three nitrogenous bases called a triplet or codon. The process is called transcription.
- Transfer RNA (tRNA): each tRNA collects a specific amino acid from the cytoplasm, depending on the order of the nitrogenous bases and carries it to a ribosome.
- Ribosomal RNA (rRNA): form the ribosomes and produce the proteins based on the information from the tRNA.

HINT: Please learn the differences between DNA and RNA

RNA	DNA
Ribose pentose sugar	Deoxyribose pentose sugar
Single unwound strand of nucleotides	Double helix strand of nucleotides
Contains uracil	Contains thymine

SECTION C: HOMEWORK EXERCISE *(Taken from Viva Life Science Grade 12)*
QUESTION 1

1. Study the following diagram and answer the questions that follow.

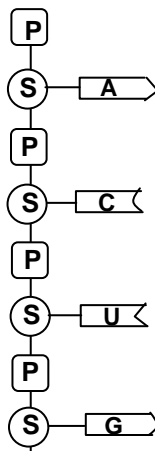


- (a) Identify parts b, d and e. (3)
- (b) Give the LETTERS in sequence that will make up any one nucleotide. (3)
- (c) What is the main function of part labelled e? (1)
- (d) The sequence of the bases could sometimes change. What is this changed in sequence called? (1)
- (e) List TWO processes that could result in the change referred to in 'd'. (2)
- (f) What type of molecule does the above diagram represent? Provide a reason for your answer. (2)

[12]

QUESTION 2

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



- (a) Identify this type of nucleic acid. (1)
- (b) Provide TWO visible reasons for your answer. (2)
- (c) Why are there no hydrogen bonds present? (1)
- (d) Name the type of sugar represented by the letter S. (1)
- (e) Name three different types of the above molecule. (3)

[8]

SECTION D: SOLUTIONS TO SECTION A

- 1.1.1 DNA✓ (1)
- 1.1.2. 1 = Hydrogen bond✓
5 = Cytosine✓ (2)
- 1.1.3 Nucleotide✓ (1)
- 1.1.4 - DNA produces two exact copies of itself. ✓
- During interphase/before cell division ✓.
- Two chromatids that are identical are formed✓
- The two chromatids are identical to that of the parent✓ (Any 2) (2)
(You must ensure that you know this process well)
- 1.2.1 (a) The synthesis of mRNA✓ from a DNA template✓/by complementary matching of the nitrogenous bases in DNA (2)
(b) The process of converting the information carried by mRNA✓to the correct sequence of amino acids ✓to form a particular protein✓ (Any 2) (2)
- 1.2.2 CAA✓UAC✓ACC✓ (in sequence) (3)
- 1.2.3 Phenylalanine✓ Valine✓Methionine✓ (in sequence) (3)
- [16]**
- 2.1 Transcription✓ **(You must know the definition)** (1)
- 2.2 5✓ (1)
- 2.3 GCU✓ – CAU✓ – UGG✓ (3)
- 2.4 (a) The sequence of the amino acids will change✓/the actual amino acids could change (or name any specific change)
A different protein could form✓/structure of protein will change (2)
(Remember that proteins consist of many amino acids. They are the building block of a protein)
- (b) Mutation✓/deletion (1)
- 3.1. 2 = mRNA (1)
3 = amino acid (1)
- 3.2. C,G, U, U, G, U, A, A, A, (1/3 mark each) (3)
- 3.3. 4 = arginine
5 = cysteine
6 = lysine (3 x 2) (6)
- [11]**
- 4.1 A
- 4.2 C
- 4.3 A
- 4.4 C
- 4.5 B (1 x 5) [5]

TOPIC 2: PROTEIN SYNTHESIS AND DNA FINGERPRINTING

Learner Note: Please revise the structure of DNA and the functions of the 3 types of RNA before proceeding with Protein Synthesis. You must know that the resulting amino acid is based on the codon copied from the original DNA. Protein synthesis is questioned regularly in examinations so you must understand the basics before moving on to the process of protein synthesis. When working through DNA fingerprinting, use a ruler when checking the DNA VNTR patterns. This way, you will very easily pick up where the markers are the same. Research forensic science and DNA fingerprinting, and consider forensic science as a possible career.

SECTION A: TYPICAL EXAM QUESTIONS**QUESTION 1: Multiple-choice 10 minutes**

HINT: 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: 3. Look at the options. 4. 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 ?. 5. If you still do not know the answer, then select the ?

1.1 DNA is found

- A. in a gene
- B. on a nucleus
- C. on a membrane
- D. on chromosomes

1.2 The building blocks of nucleic acids are called

- A. nucleotides
- B. nucleoli
- C. nucleosides
- D. nucleocodes

1.3 The sugar molecule present on RNA is

- A. sucrose
- B. ribose
- C. deoxyribose
- D. glucose

1.4 Which of the following is a complimentary base pair normally present in the DNA molecule?

(REMEMBER THE RULE: G = C and A = T/U)

- A. thymine and cytosine
- B. thymine and guanine
- C. cytosine and uracil
- D. adenine and thymine

1.5 During protein synthesis the following steps take place in order:

- A. DNA unwinds, transcription by mRNA, anticodons produced by tRNA, amino acids combine to form polypeptides
- B. DNA unwinds, anticodons produced by mRNA, transcription by tRNA, amino acids combine to form polypeptides
- C. DNA unwinds, transcription by mRNA, codons produced by tRNA, amino acids combine to form polypeptides
- D. DNA unwinds, transcription by mRNA, anticodons produced by tRNA, amino acids are formed

1.6 Select the correct difference between a DNA and RNA:

(Tick all the correct points and cross all the points that are wrong; then select your answer.)

	DNA	RNA
A	Ribose pentose sugar	Deoxyribose pentose sugar
B	Double helix strand	Single helix strand
C	Contains Thymine	Contains Uracil
D	Contains triplet bases	Contains only anticodons

1.7 Which part of the cell is the site of protein synthesis?

- A. the chromosomes
- B. the nucleus
- C. the cytoplasm
- D. the ribosomes

1.8 The monomers of proteins are:

- A. nucleotides
- B. triplets
- C. anticodons
- D. amino acids

1.9 In DNA fingerprinting, scientists use a small number of sequences of DNA called

- A. mtDNA
- B. tRNA
- C. VNTR
- D. triplet bases

1.10 Which of the following are uses of DNA fingerprinting?

- 1. Matching paternity
- 2. Identification of a body
- 3. Detecting bacteria in pollutants
- 4. Keeping criminals in jail
- 5. Studying migration patterns

- A. 1, 2, 3, 5
- B. 1, 2, 3, 4
- C. 1, 2, 4, 5
- D. 2, 3, 4, 5

[10]

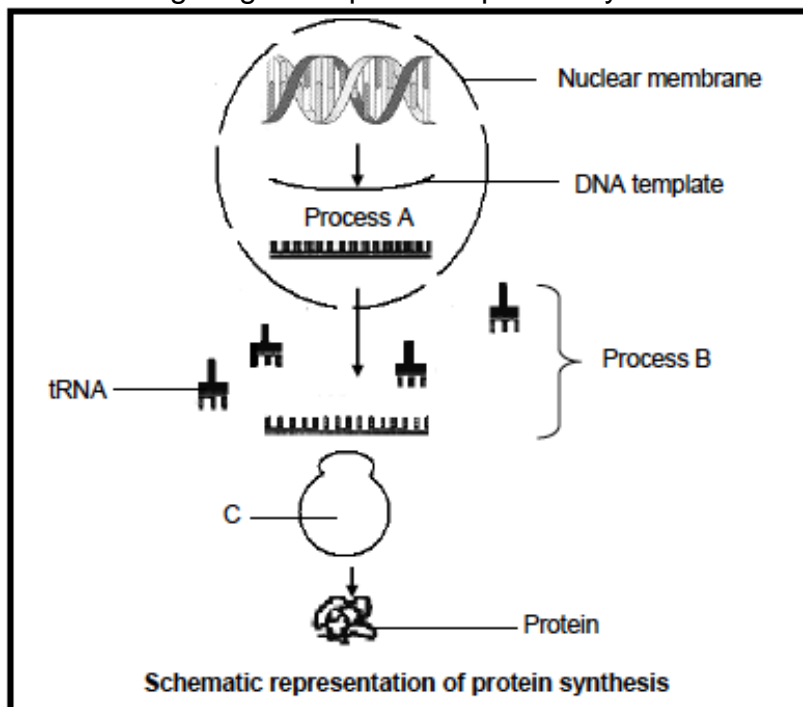
HINT: With this type of question, read through options 1 to 5 and tick those that are correct and apply to the question. Cross out those that do not. Select your answer from the ticked options

QUESTION 2: 20 minutes

(Taken from DoE November 2008 Paper 1)

(Reminder: always complete the labels on a diagram before you move on to the questions)

The following diagram represents protein synthesis:



- 2.1 Name the following processes: (1)
 (a) A (1)
 (b) B (1)
- 2.2 Name the organelle labelled C. (1)
- 2.3 Explain how the mRNA is made from the DNA template during process A. (5)
(Reminder of transcription)
- 2.4 Processes A and B above can be summarised by the table below. Write the numbers 1 – 3 and next to each number the nitrogenous bases that will complete the table. (6)
(Reminder: The DNA has a code. The mRNA is always the opposite complimentary bases to the DNA, and the anticodons on the tRNA will always be the same as the DNA. Thymine on DNA is replaced with Uracil on the RNA)

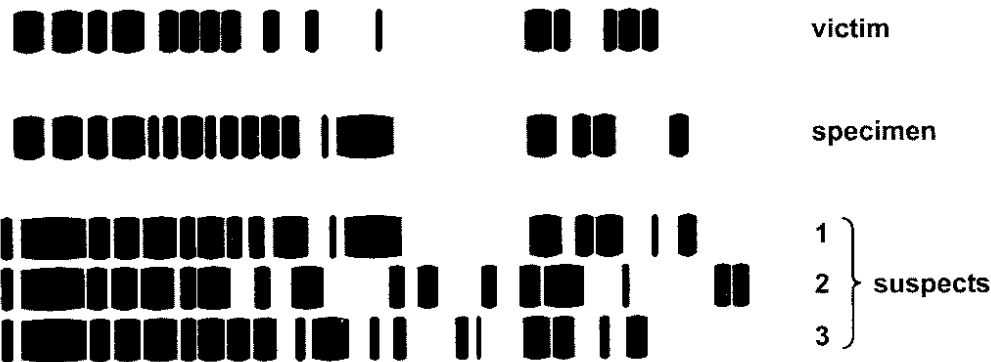
Base sequence on DNA	Codon on mRNA	Anticodon on tRNA	Amino acid
CAA	1	2	Valine
3	GCA	CGU	Alanine

[14]

QUESTION 3: 10 minutes

The DNA in all cells of an individual is identical and the sequence of nucleotides in DNA is represented by a pattern of dark bands called the DNA fingerprint. Forensics involves comparing a crime suspect’s genetic profile with the blood of a crime victim and with human biological material such as hair, blood, skin fragments or semen found at the scene of the crime. Forensic detectives have gathered evidence from a crime scene and have arrested three suspects. Using the genetic fingerprints below, state which of the suspects is the guilty party and provide a reason for your answer. [7]

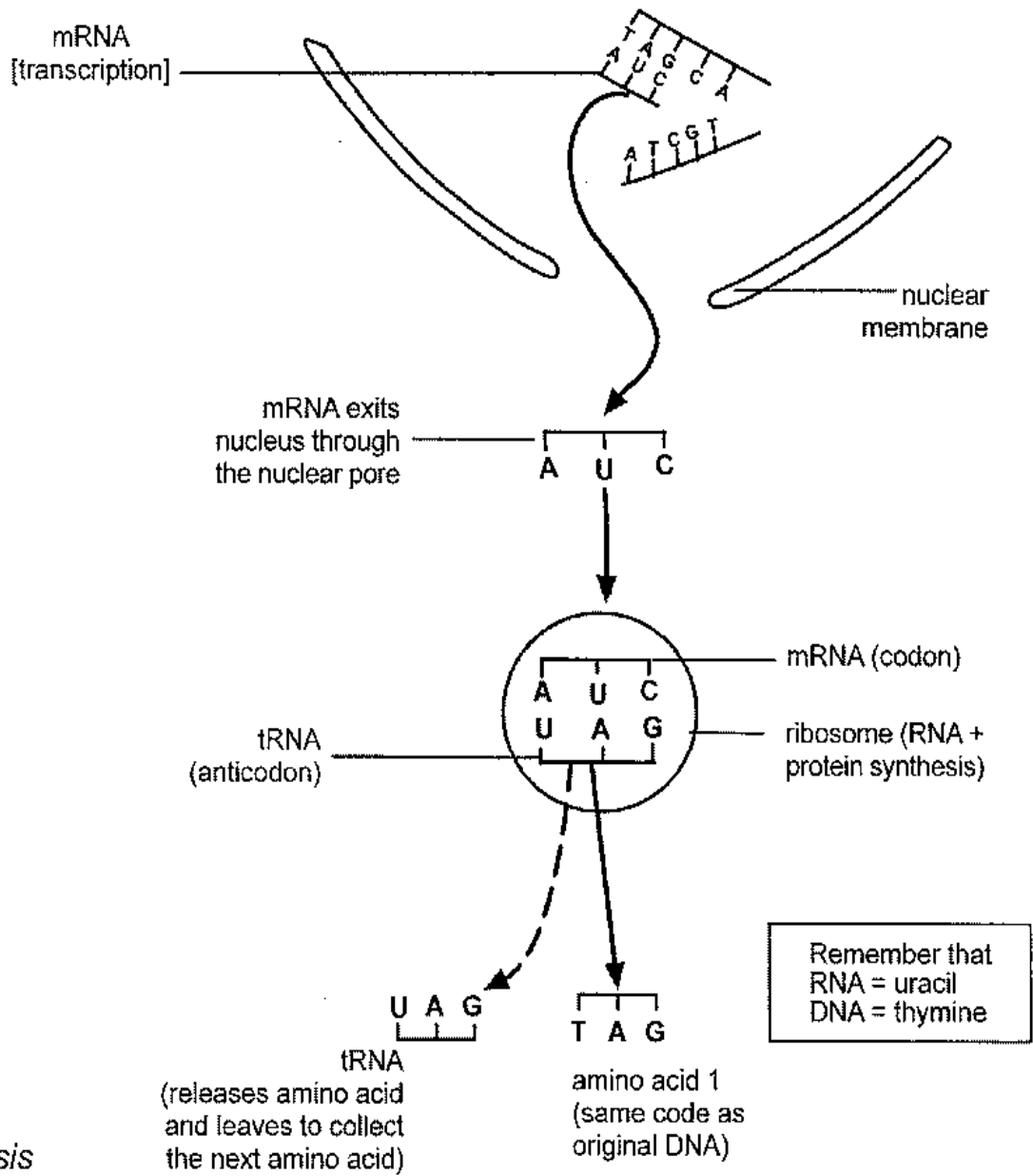
(Reminder: Use a ruler to check for corresponding VNTR tracers – e.g. the 3rd tracer from the left is the same for the victim, the specimen and the suspects)



SECTION B: ADDITIONAL CONTENT NOTES**1. PROTEIN SYNTHESIS**

Proteins are macro molecules and always contain the elements **carbon, hydrogen, oxygen and nitrogen** (C, H, O, N). Some proteins contain sulphur and phosphorus as well. Proteins are made up of building blocks called amino acids (like bricks that are used to build a house. The amino acids are like the bricks, and the house is like the protein). Every living organism consists of proteins because all cells, hormones (except sex hormones), antibodies, blood and enzymes consist of proteins.

A protein is made up of 40 to a 1 000 amino acids, joined together in a variety of combinations. Amino acids are held together by **peptide bonds** to form peptide chains. The peptide chains join together to form proteins by a process called **polymerization**. This results because of protein synthesis to provide the sequence of the individual amino acids combination. Any small deviation or change will result in the protein losing the ability to function, or it can cause a **mutation**.



Protein synthesis

Schematic representation of Protein Synthesis.

Protein Synthesis - The Process

Step 1: Transcription (Remember that RNA contains uracil in place of thymine on the DNA)

- The enzyme RNA polymerase causes the DNA to unwind and separate in the nucleus.
- One DNA strand provides the code which is copied onto an mRNA (messenger RNA) strand in the nucleus. Each code on the DNA consists of three bases, called a triplet.
- Each mRNA strand consists of three bases called a codon, per DNA code triplet.
- So, the sequence of the bases in the DNA strand will determine the sequence of the bases in the mRNA – per codon.
- **This process of copying the triplet code onto the mRNA is called transcription.**
- If the sequence of the DNA triplet is CCC, TAA and CAG, then the mRNA will build codons of GGG (for the CCC), AUU (for the TAA) and GUC (for the CAG), which will be the complementary bases.
- When the **mRNA is coded**, it leaves the nucleus through the nucleopore and carries the message as a codon to the ribosomes in the cytoplasm. The codon will provide the ribosome with the code to synthesise a specific piece of a protein.

Remember that RNA contains uracil in place of thymine on the DNA

Step 2: tRNA has an anticodon – it has the opposite bases to the codon. It picks specific amino acid and carries it to the ribosome where mRNA codon determines the **anticodon fit**. The tRNA carries the amino acid to the ribosomes according to the template formed by the codon of the mRNA. The mRNA will, therefore, determine which anticodons will fit; for example the mRNA codon of GGG will only accept the tRNA anticodon of CCC.

Remember that the CCC was originally on the DNA triplet.

Step 3: Translation: the tRNA releases the amino acid into the correct place on the polypeptide chain (many peptides) and leaves to collect the next amino acid. The **processing of the information carried by the mRNA into an amino acid sequence during protein synthesis is known as translation.**

The process of protein synthesis will continue until enough proteins have been produced. The mRNA breaks up into separate nucleotides and is stored in the nucleolus. The tRNA moves back into the cytoplasm, ready to be reused at a later stage. Each protein is formed specifically to the **genetic code** of the organism and is stored on the DNA in the nucleus of each cell. The cell selects the specific protein that must be produced by selecting the specific part of the DNA that will be copied as mRNA. Any change during this coding will result in a **mutation**.

An example of base triplet, codon and anticodon combinations:

Amino Acid	Base triplet of DNA	Codon of mRNA	Anticodon of tRNA
Alanine	CGA	GCU	CGA
Histidine	GTC	CAG	GUC
Valine	CAT	GUA	CAU
Serine	AGA	UCU	AGA

(Remember that **Uracil** is present in all RNA and replaces the **Thymine** on the DNA.)

Why is protein synthesis important?

- Process to produce **specific proteins** required for cells, antibodies, blood, enzymes and hormones
- Proteins are a **reserve energy source** in the body
- **Nucleoproteins** present in the chromosomes are important for cell division and heredity
- **Conjugated proteins** like haemoglobin (transports oxygen to all the cells in the body) and lipoproteins (necessary to form cell membranes and organelles) are essential for the body to function properly.

2. DNA fingerprinting

All living organisms have DNA with the same basic chemical structure. The differences are in the order of the nitrogenous base sequences.

All humans have two eyes, a nose and a mouth yet everyone (except identical twins) looks different because each set has a different shape and structure that is individual to each person.

Each person's DNA is unique to that specific person. Scientists use **DNA markers**, by designing small pieces of DNA called **probes**, to establish a person's **DNA profile**. The probes bind to complementary DNA sequences and formulate a unique pattern for the individual. A selection of DNA sequences within the profile forms what is termed the **VNTR** pattern for that person. A sample of hair, blood, skin cells, mouth cells, tissue and body products are used to establish the VNTR. Forensic scientists are able to compare the DNA profiles to a sample that is provided from a crime scene. DNA profiling is very accurate and a criminal can be easily identified. However, there are many more uses of DNA fingerprinting, than merely to catch criminals.

- **To match paternity and maternity:** The first step in identifying a father would be **blood group** identification. Blood group testing can only prove that an individual is *not* the father because thousands of people have the same blood group.

If a man's blood group is Type O and the baby is also Type O, it does not prove that this is the baby's father because this is the most common blood group. There are many men with this blood group. If the man's blood group is Type AB, then the baby is definitely not his.

When the child's blood group is the same as that of the possible father, DNA fingerprinting is used to prove whether an individual is in fact the father. Remember, an individual inherits his or her specific VNTRs from the parents.

- **Criminal identification and forensics:** DNA samples of blood, hair, skin and seminal fluid that is found at the crime scene is collected for analysis. The VNTR of criminal suspects is compared to the samples. Usually, **four to five matches** must be found at various locations on the individual's genome (DNA profile) for it to be regarded as a match. VNTR is used to determine guilt or innocence and this evidence is regarded as irrefutable (cannot be doubted).
- **Identifying sexual offenders and rapists:** Forensic scientists use the Y chromosome that is found in the sperm, as the unique genetic marker. The VNTR is established and samples from the suspects is analysed and compared. The process is especially helpful when more than one male is involved as the process is able to identify each individually.
- **Identifying suitable organ donors:** The VNTR of the donor and recipient is compared to establish compatibility. There can never be a perfect match, so the donor with the closest match is used. The donor need not always be a relative. In some cases, an organ of a cadaver (deceased person) is a close enough match, and the organ is transplanted.
- **Identifying a body:** Mitochondrial DNA analysis (mtDNA) is used to identify a body. A mother will have the same mtDNA as her child because the egg cell contains the mitochondria of each new embryo. The sperm contributes only nuclear DNA. The mtDNA profile is used to identify the remains of the corpse in missing person cases.

SECTION C: HOMEWORK

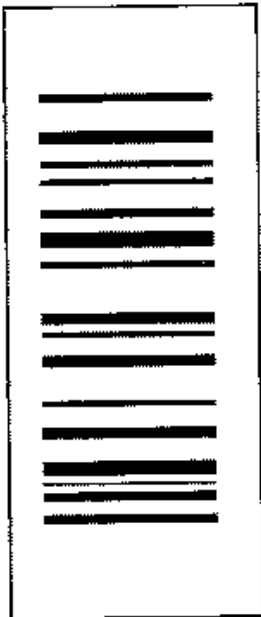
Learner Note: If you have difficulty with the homework questions, refer to the content notes or refer to your class teacher for assistance.

QUESTION 1

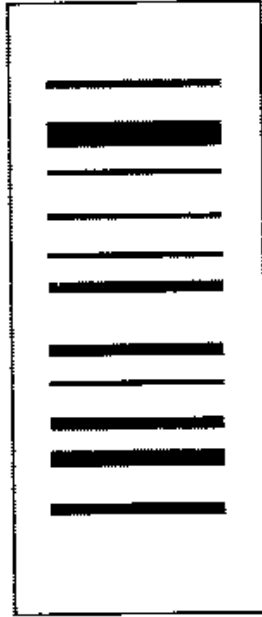
A child is born out of wedlock. The mother needs to claim maintenance for the child, but does not know which one of two men is the father. She has had blood tests done, but both the men have the same blood type. Her next alternative is to do DNA fingerprinting. Both men provide samples and the VNTR of both is analysed. The results are below. Identify the real father and explain how you reached your conclusion. [3]

(Remember to use a ruler to check the corresponding VNTR codes)

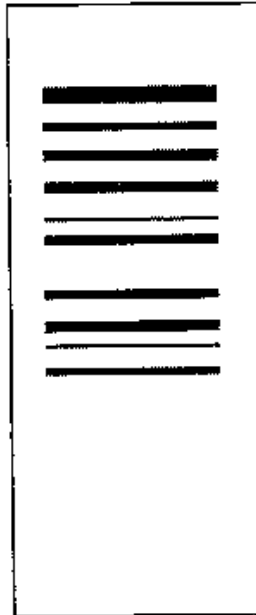
Mother



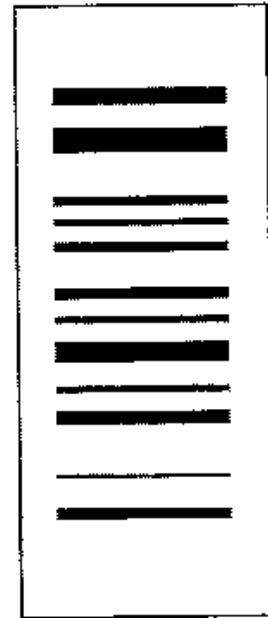
Child



Male 1



Male 2



QUESTION 2

Describe the process of protein synthesis.

[16]

QUESTION 3

Provide THREE reasons why protein synthesis is important.

[3]

SECTION D: SOLUTIONS TO SECTION A**QUESTION 1**

1. D
2. A
3. B
4. D
5. A
6. C
7. D
8. D
9. C
10. A

[10]**QUESTION 2**

2.1 (a) A - Transcription (1)

(Ensure that you know the definitions and processes for A and B)

(b) B – Translation (1)

2.2 C - Ribosome (1)

2.3 - Process is called transcription✓

- Free (RNA) nucleotides✓

- from the nucleoplasm✓

- arrange according to the base sequence✓ of the DNA template

- in a complementary✓ way

- A –U✓

- C –G✓

- Sugar-phosphate bonds form✓ between nucleotides to form required mRNA

- Process controlled by enzymes✓

max (5)

2.4 1 –GUU✓✓

2 –CAA✓✓

3 –CGT✓✓

(3 x 2) = (6)

[14]**QUESTION 3**

Suspect 1 ✓✓

The VNTR ✓ of suspect 1 had 6 matches ✓ to the specimen ✓ found at the crime scene.

Suspect 2 ✓ and 3 ✓ showed no matches

[7]

SESSION 2: TOPIC 1: MEIOSIS

Learner 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 as this forms the basis and grounding for genetic variation and hereditary characteristics in Genetics and Reproduction. Learn the relevance of diseases and syndromes resulting from mutations caused during meiosis.

SECTION A: TYPICAL EXAM QUESTIONS 35 minutes**QUESTION 1: Multi-choice question: 10 minutes**

HINT: When answering multi-choice: 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: 3. Look at the options. 4. Try to think of why an option is wrong for the question and cross it. If there is an option that you don't know, write a ?. 5. If you still do not know the answer, then select the ?.

- The nucleus of the somatic cells of a human contains:
 - 46 identical chromosomes
 - 23 different chromosomes
 - 46 pairs of chromosomes
 - 23 pairs of chromosomes
- Mitosis is responsible for the following in plants and animals
 - growth and repair
 - gamete formation
 - reduction division
 - genetic variation
- The number of chromosomes in a zygote....
 - diploid
 - half the number in a gamete
 - haploid
 - triploid
- Karyokinesis begins during which phase?
 - Prophase
 - Metaphase
 - Anaphase
 - Telophase

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 fertilisation 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 fertilisation
 - D. the production of a diploid number of chromosomes in the gamete
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
7. Cytokinesis is the
- A. division of the nucleus
 - B. fusion of the nuclei
 - C. division of the cytoplasm
 - D. cytoplasmic streaming
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
9. Place the following steps that occur in meiosis in order:
1. crossing over of the chromatids
 2. lining up of paired chromosomes at the equator
 3. pairing of homologous chromosomes
 4. complete separation of chromatids
- A. 1, 2, 3, 4
 - B. 2, 3, 4, 1
 - C. 3, 1, 2, 4
 - D. 4, 1, 2, 3

HINT: 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.

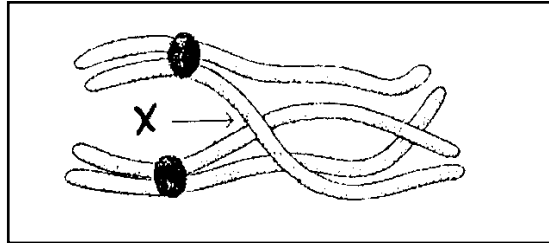
10. Why does crossing over /chiasma take place during meiosis?
- A. to ensure that the chromosomes divide evenly
 - B. to ensure that characteristics from the mother are transferred to the father
 - C. to ensure that cell division can take place
 - D. to ensure that that genetic variation is passed on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

[10]

QUESTION 2: 8 minutes*(Taken from Viva Life Science – Grade 12)*

HINT: When doing any question about Meiosis remember that crossing over during Meiosis Prophase I **AND** the random assortment of the chromosomes during Meiosis Metaphase I is what results in variation. You must know this for Genetics and also to understand Diversity.

Study the diagram below and answer the questions that follow.

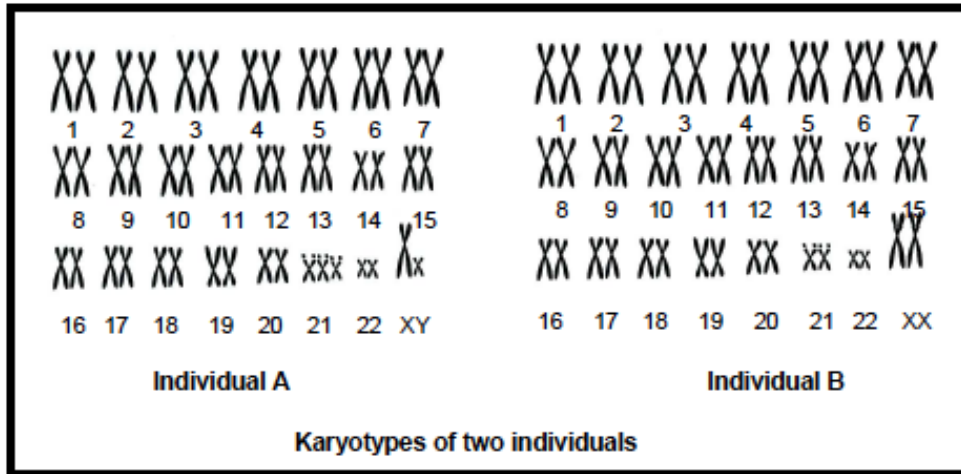


- 2.1. Name the process occurring in the diagram. (1)
 - 2.2. Provide a label for the region marked X. (1)
 - 2.3. During which phase of meiosis does this process occur? (2)
 - 2.4. List ONE importance of this process to living organisms. (1)
- [5]

QUESTION 3: 8 minutes*(Taken from DoE Exemplar 2008 Paper 1)*

HINT: Remember that the human genome is the 'blue print' for each individual's chromosome pairs. It determines and represents our individual karyotype (chromosome sets). The gonosomes will be XX in females and XY in males. Humans have 23 pairs of chromosomes – 23 from the mother and 23 from the father = 23 pairs. When there are 1 or 2 chromosomes too many in the karyotype, genetic/chromosomal disorders will result

The diagrams that follow show the sets of chromosomes (karyotypes) in two human individuals, A and B. Study the diagrams and answer the questions that follow.



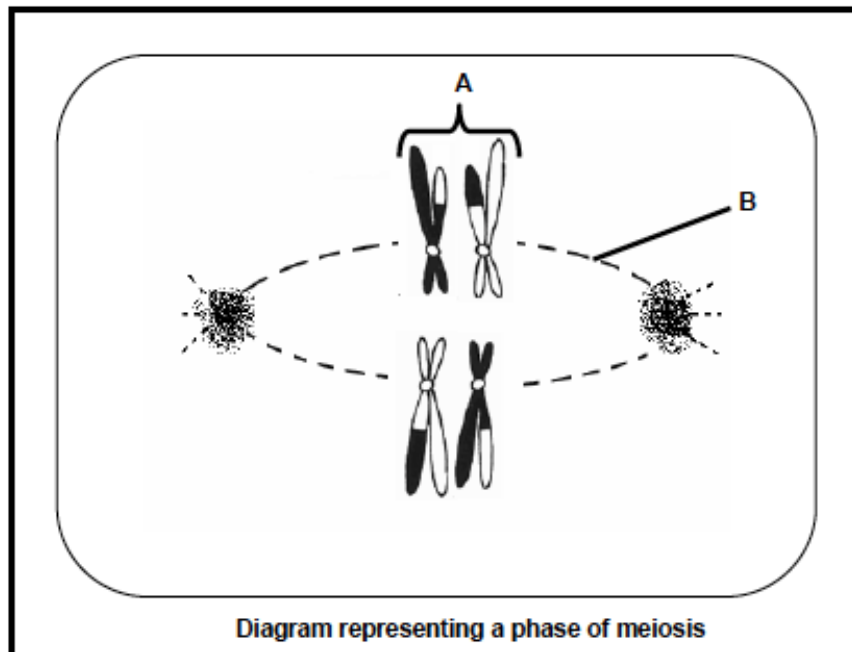
- 3.1 Which individual (A or B) is female? (1)
- 3.2 Give a reason for your answer to QUESTION 3.1. (2)
- 3.3 Identify which individual (A or B) has an abnormal number of chromosomes. (1)
- 3.4 Name the genetic disorder that the individual in QUESTION 3.3 has. (1)
- 3.5 Explain the abnormal chromosome number of the disorder named in QUESTION 3.4. (1)
- [6]

QUESTION 4: 8 minutes

(Taken from DoE Exemplar 2008 Paper 1)

HINT: You must be able to identify the various phases of Meiosis from a diagram.

The diagram below represents a phase of meiosis. Study the diagram and answer the questions that follow.



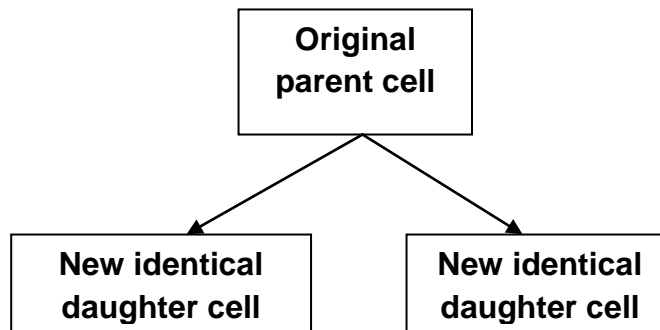
- 4.1 Write down the term that best describes the paired chromosomes labelled A. (1)
- 4.2 Identify structure B. (1)
- 4.3 What phase of meiosis is represented in the diagram above? (2)
- 4.4 How many chromosomes are shown in the diagram above? (1)
- 4.5 How many chromosomes would there be in each cell at the end of meiosis? (1)
- [6]

SECTION B: ADDITIONAL CONTENT NOTES

1. Introduction

In mitosis you learned how the chromosomes carry the genes that hold the information for each individual. During the process, the chromosomes duplicate to form **two identical daughter cells**. When cells are damaged, the surrounding cells will duplicate by mitosis and form new identical cells. Mitosis will take place to ensure:

- **growth of the organism**
- **repair of damaged cells**
- **replacement of cells that cannot be repaired**
- **reproduction in single-celled organisms** (only one cell so they do not have reproductive structure and reproduce by duplicating the parent cell)



2. The Process of Meiosis

For sexual reproduction to take place, a haploid male gamete will fuse with a haploid female gamete during **fertilisation**. The result is a diploid **zygote**.

haploid	+	haploid	=	diploid
half	+	half	=	whole

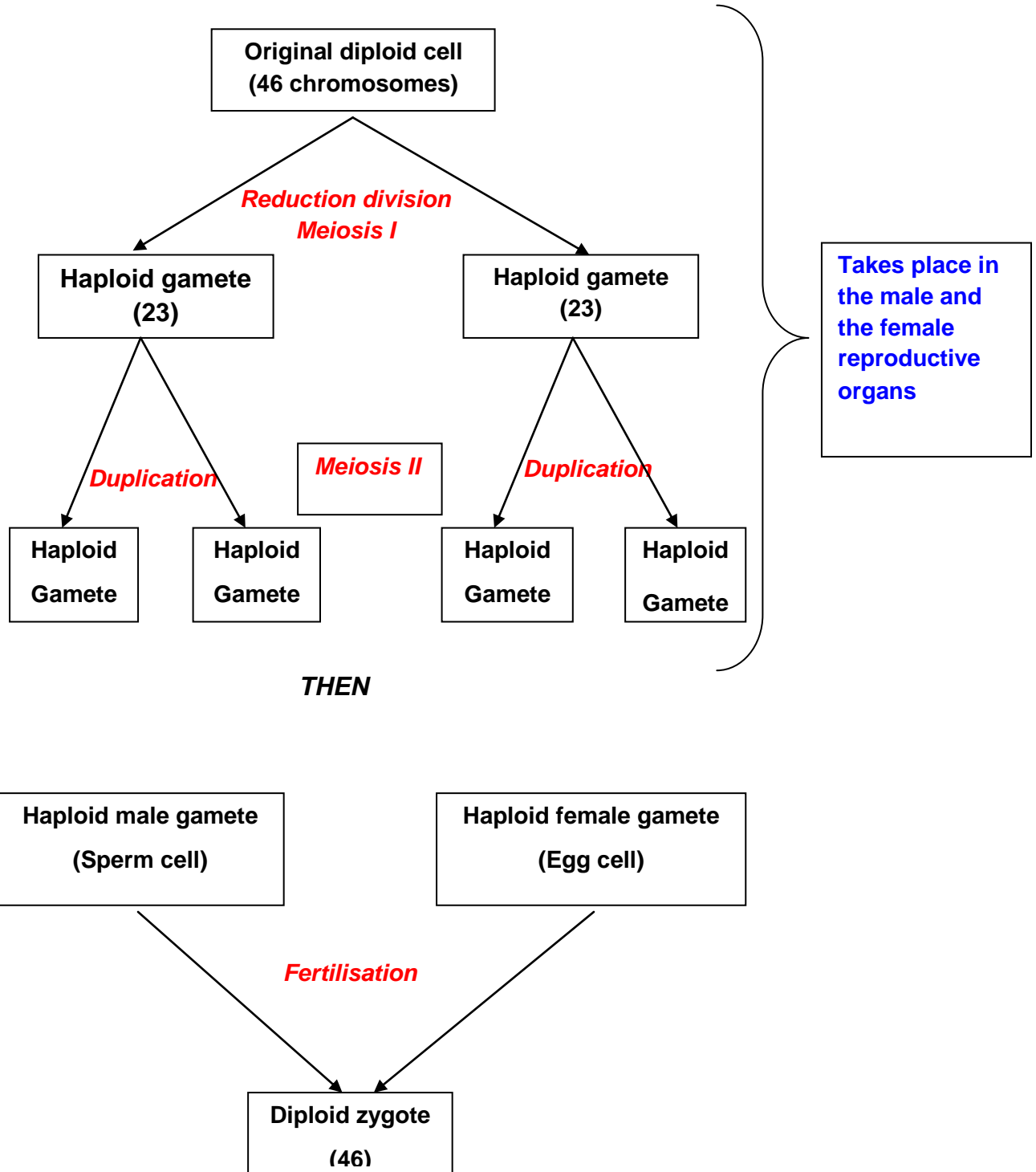
- Each gamete contains **half** of the chromosomal number of the body cells. This means that each gamete must contain one set of the double set of chromosomes in the original cell nucleus.
- The process of meiosis takes place so that each gamete contains **one complete set** of chromosomes.
- The zygote will contain **two complete sets** of chromosomes – one from the male gamete and one from the female gamete.
- The growth and development of the zygote will then occur by the process of mitosis.

In humans, each body cell contains **46 chromosomes** (diploid). One set of 23 chromosomes will come from the mother in the egg cell (haploid female gamete). The second set of 23 chromosomes will come from the father in the sperm cell (haploid male gamete). When there are two sets of chromosomes, the nucleus is diploid ($2n$) and complete. When we refer to **one set** of chromosomes in the gamete, it is called **haploid (n)**. Haploid represents 23 chromosomes and diploid represents 46 chromosomes.

The two steps of the meiosis process:

- **Meiosis I (first meiotic division):** this is called reduction division where the chromosome number in the nucleus is halved. The resulting gametes are haploid.
- **Meiosis II (second meiotic division):** this process is similar to mitosis. The haploid gametes duplicate so that in males, four sperm cells result. In females, one gamete forms the egg cell and the three remaining gametes provide nutrition for the egg cell.

The process of Meiosis simplified:



3. Significance of Meiosis

The process of meiosis takes place to:

- Produce haploid gametes from diploid chromosome pairs, in preparation for sexual reproduction
- the formation of haploid sperm cells during meiosis is called spermatogenesis
- the formation of haploid egg cells during meiosis is called oogenesis
- Ensure that the chromosome number remains the same in the offspring as in the adult ($n + n = 2n$)
- Ensure genetic variation when crossing over takes place during Prophase I

4. The Production of Sex Cells

The production of sex cells is grounding for Reproduction and Genetics. Meiosis takes place in specialised cells located in the reproductive system, to ensure sexual reproduction:

In animals:

- male gametes/spermatozooids are produced in the **testes**
- female gametes/egg cells are produced in the **ovaries**

In plants:

- special cells in the pollen sacs of the anthers divide by meiosis to produce the **pollen grains** containing the male gametes
- a specialised cell in the ovule divides by meiosis to produce the **embryo sac** containing the egg cell

The 23 pairs of chromosomes that result in a zygote are divided as follows:

- 22 pairs of autosomes
- 1 pair of sex chromosomes represented by **XX** in females
XY in males

A **karyotype** is a set of chromosomes from a human cell, that shows the chromosomes arranged according to their numbers. Number 1 is always the largest while number 22 is the smallest. The female karyotype will have XX as number 23 and the male will show XY as number 23. See the following karyotypes.

5. Diseases and syndromes

Sometimes changes take place in the chromosome number during meiosis. Each nucleus should contain 23 chromosomes after meiosis but if one nucleus contains 22 while the other has 24, it creates problems. When either of these resulting gametes joins with a normal gamete, the result could be:

$23 + 22 = 45$ or $23 + 24 = 47$ chromosomes. If this happens, abnormalities result.

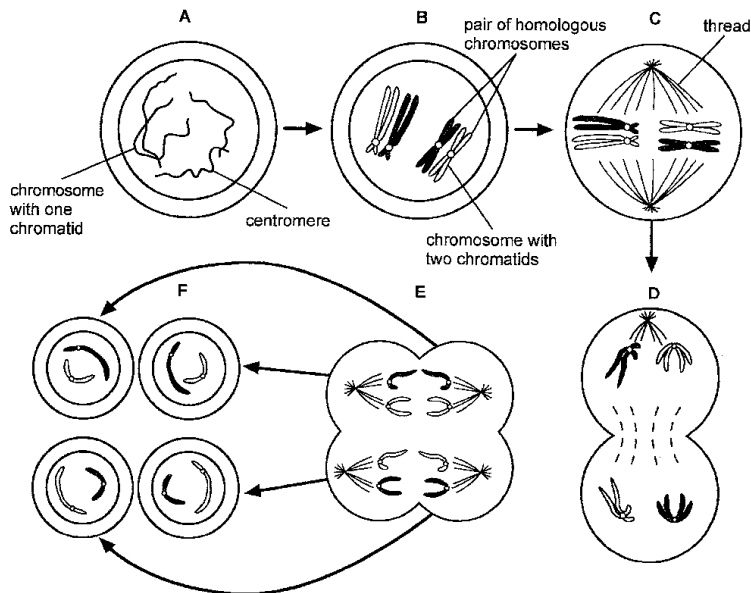
- **Down's Syndrome:** The Down's syndrome baby has 47 chromosomes. The mother's egg cell has 24 chromosomes + the father's sperm cell that has 23 chromosomes. The child will have 45 autosomes, with three number 21 chromosomes instead of the normal pair and one pair of sex chromosomes. Women over the age of 40 have a 1/12 chance of producing gametes that have 24 chromosomes.
- **Klinefelter's Syndrome:** Klinefelter's syndrome results from 47 chromosomes. The baby has 44 autosomes and three sex chromosomes - XXY. It is a relatively common genetic abnormality and occurs in 1/500 males.
- **Turner's Syndrome:** Turner's syndrome results when one of the X chromosomes is absent from the male or female gamete. The baby has 44 autosomes and only one X chromosome. This disorder occurs in 1/3000 births as 95% of the foetuses are spontaneously miscarried.

SECTION C: HOMEWORK

Learner Note: If you have difficulty with the homework questions, refer to the content notes or refer to your class teacher for assistance.

QUESTION 1

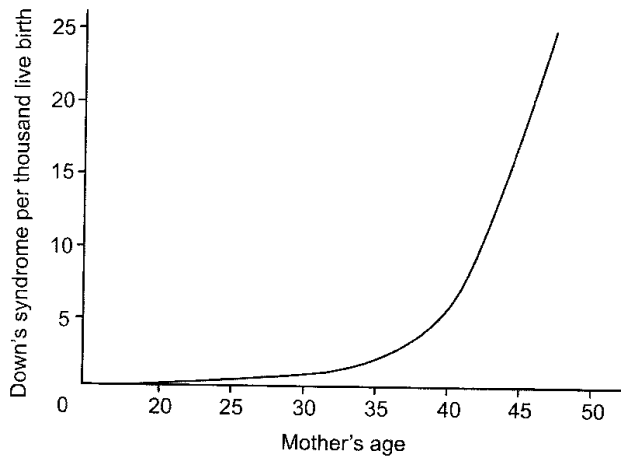
Study the diagrams below on the principle of meiosis. Answer the questions that follow:



- 1.1. How many chromosomes does cell B have? (1)
 - 1.2. Would this be n or $2n$? Give a reason for your answer. (2)
 - 1.3. How many chromosomes does each cell in F have? (1)
 - 1.4. What would the ploidy of each cell in F be? (1)
 - 1.5. Does each cell in F have exactly the same number of chromosomes? (1)
- [6]

QUESTION 2

The graph below shows the relationship between the number of babies born with Down's syndrome and the age of the mother.



- 2.1. Discuss the shape of the graph. (3)
 - 2.2. What is the difference in the number of chromosomes between a normal baby and a baby with Down's syndrome? (2)
 - 2.3. What is your view on the termination of pregnancy if a woman discovers she is carrying a foetus with Down's syndrome? Support your answer with a reason. (2)
- [7]

SECTION D: SOLUTIONS TO SECTION A

QUESTION 1

- | | |
|--------|---------|
| 1.1. D | 1.6. D |
| 1.2. A | 1.7. C |
| 1.3. A | 1.8. B |
| 1.4. B | 1.9. C |
| 1.5. C | 1.10. D |

[10]**QUESTION 2**

- | | |
|---|-----|
| 2.1. crossing over ✓ | (1) |
| 2.2. X – chiasmata ✓ (this is the actual point where the chromosomes touch) | (1) |
| 2.3. prophase I ✓✓ (Reminder: the 'I' means meiosis I/ 1st meiotic division. So a 'II', e.g. metaphase II will mean that this is metaphase in the 2nd meiotic division) | (2) |
| 2.4. To ensure genetic variation ✓ in the organism. | (1) |

[5]**QUESTION 3**

- | | |
|--|--------------------|
| 3.1 B | (1) |
| 3.2 XX✓chromosomes✓/ Two identical sex chromosomes ✓✓ | (Any 2) (2) |
| 3.3 A | (1) |
| 3.4 Down's syndrome (Reminder: 23 + 24 = 47 chromosomes) | (1) |
| 3.5 Caused by a faulty meiotic division✓/oogenesis during production of the ovum✓/spermatogenesis during sperm production✓ | |
| - The chromosomes of chromosome pair 21 fail to separate✓ | (Any 1) (1) |

[6]**QUESTION 4**

- | | |
|----------------------------------|-----|
| 4.1 Homologous | (1) |
| 4.2 Spindle thread/spindle fibre | (1) |
| 4.3 Metaphase 1 | (2) |
| 4.4 4 | (1) |
| 4.5 2 | (1) |

[6]

TOPIC 2: GENETICS - TERMS

Learner Note: You MUST understand the link between meiosis and genetics. During the crossing over in prophase I of meiosis and the metaphase I, chromosomes share information and then during metaphase, separate 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. Pedigree charts are a popular way to express family history. In a pedigree chart, first establish which of the individuals are **homozygous recessive** for a gene combination, as this is always a surety and can easily be seen on the chart. There are basically **FOUR crosses**. If you know these crosses, you should not have a problem.

Let's use hair colour: B = brown hair colour (dominant hair colour) b = blonde hair colour (recessive)

CROSS EXAMPLE 1

P₁ BB x bb

Gametes	b	b
B	Bb	Bb
B	Bb	Bb

F₁Genotype: 4:4 Bb heterozygous offspring (always include the ratios)

Phenotype: 100% brown (always include the %)

CROSS EXAMPLE 2:

P₁ Bb x Bb

Gametes	B	b
B	BB	Bb
b	Bb	bb

F₁Genotype: 1:4 BB homozygous offspring

2:4 Bb heterozygous offspring

1:4 bb homozygous

Phenotype: 75% brown and 25% blonde

CROSS EXAMPLE 3:**P₁****BB x Bb**

Gametes	B	b
B	BB	Bb
B	BB	Bb

F₁Genotype: 2:4 BB homozygous offspring
2:4 Bb heterozygous offspring

Phenotype: 100% brown

CROSS EXAMPLE 4:**P₁****bb x Bb**

Gametes	B	b
b	Bb	Bb
b	bb	bb

F₁Genotype: 2:4 Bb heterozygous offspring
2:4 bb homozygous offspring

Phenotype: 50% brown and 50% blonde

SECTION A: TYPICAL EXAM QUESTIONS

HINT: Remember that there are only 4 basic types of crosses. Make sure you are able to use them properly. Do a quick cross next to the relevant question to find the correct answer.

QUESTION 1: Multi-choice**7 minutes**

- The term for the physical appearance of an organism due to the genetic composition:
 - heterozygous
 - genotype
 - homozygous
 - 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 x bb
 - B BB x Bb
 - C BB x bb
 - D Bb x Bb
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 white rabbit crossed with a purebred black rabbit were crossed. 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

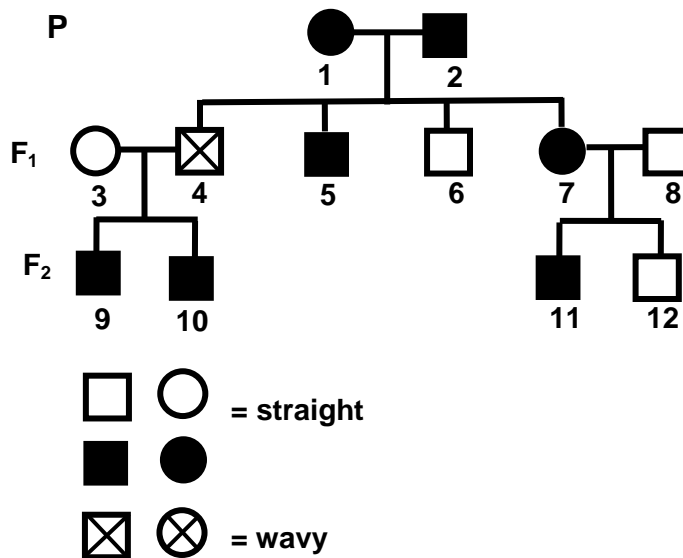
[7]

QUESTION 2: 11 minutes

HINT: The following question is based on a pedigree chart. In this chart, 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



- 2.1. Wavy hair is dominant.
- 2.2. Individual 1 is homozygous
- 2.3. If individual 6 married a woman with straight hair, all of the offspring would have straight hair.
- 2.4. Individual 4 is homozygous.
- 2.5. One of the parents of 2 had the same genotype as 2.
- 2.6. If 10 married someone with wavy hair, the first child would have wavy hair
- 2.7. If 1 and 2 had another child, the child would have curly hair.
- 2.8. If 3 and 4 had more children than those shown, they might have straight hair. [8]

QUESTION 3: 6 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.

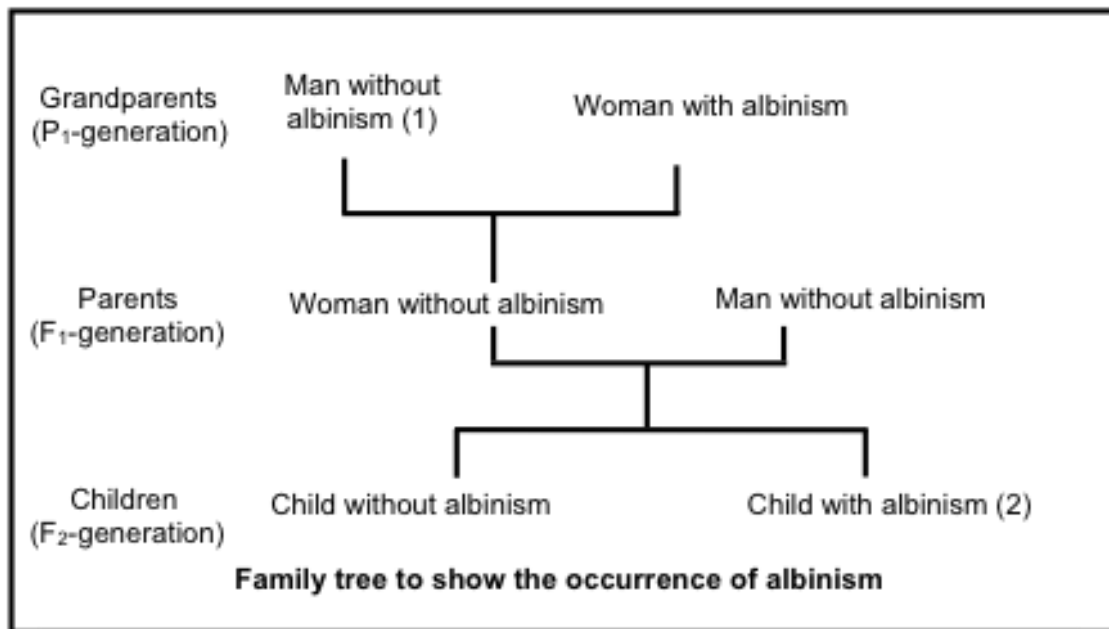
Using the symbols B and b to represent the two alleles for fur colour, show as a punnett square, a genetic cross between a mouse that is heterozygous for fur colour with a mouse with brown fur. Show the possible genotypes and phenotypes of the offspring. [6]

HINT: Check the content summaries for the mark allocation for any cross that you do. Remember to include P^1 and F^1 , as well as genotype and phenotype – ratios and % in your work.

QUESTION 4: 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.

HINT: This is a pedigree chart. Always first mark the homozygous recessive individuals on the chart 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'.



4.1. Indicate whether each of the individuals below could be homozygous dominant, homozygous recessive or heterozygous:

- (a) 1
(b) 2

(3)

4.2. Explain your answer to QUESTION 4.1 (a).

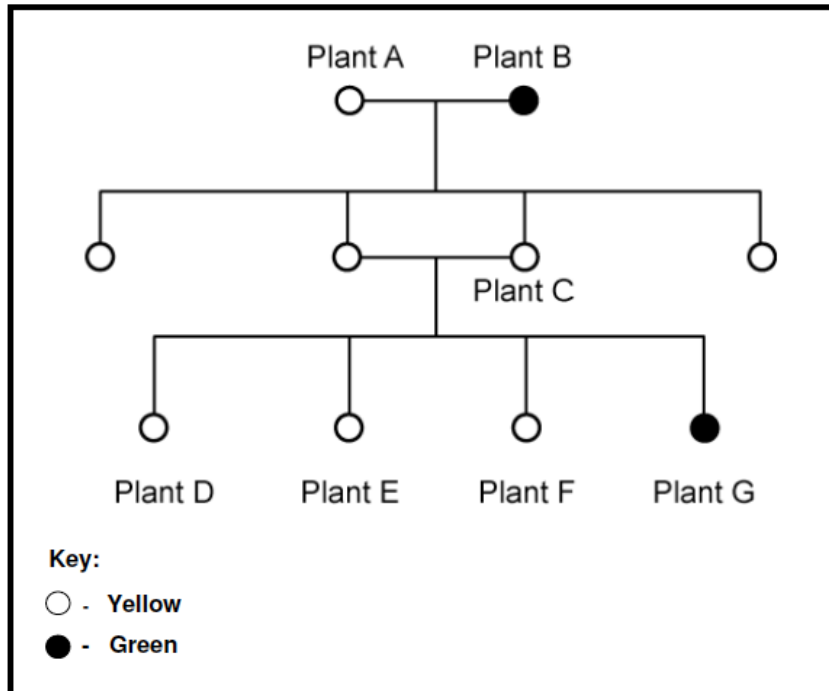
(2)

[5]

QUESTION 5: 6 minutes*(Taken from Free State Prelim Paper 2009)*

Sello crosses two pure breeding garden pea plants in the laboratory. Plant A produces yellow peas and plant B green peas. He knows that the gene, 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)



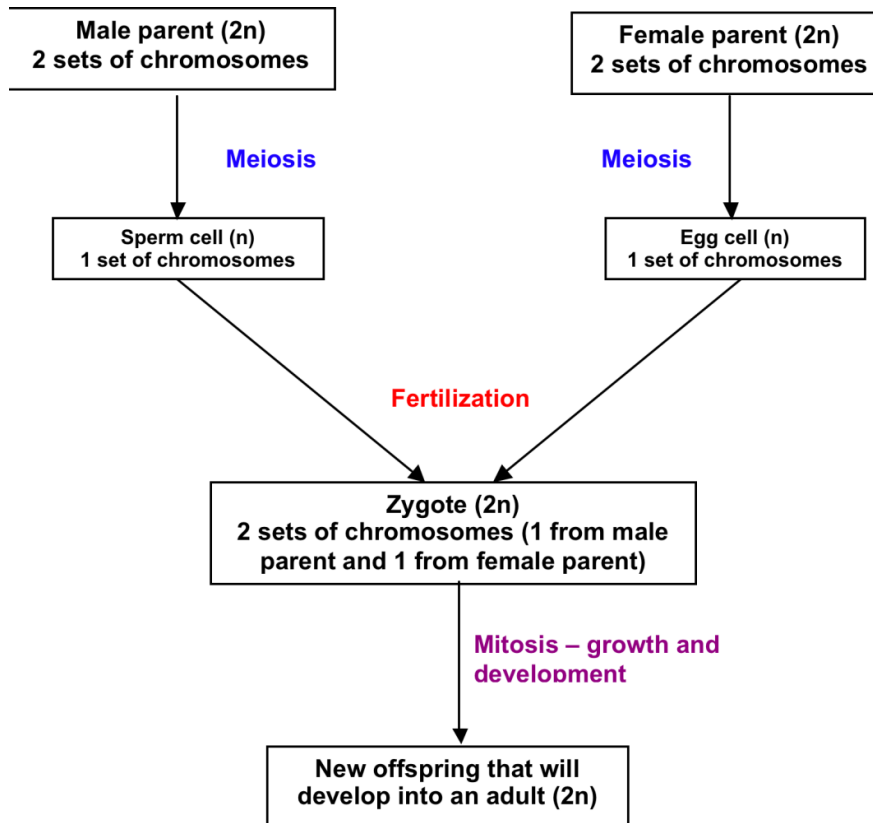
- 5.1. Give the genotype for plant A and plant B. (2)
 - 5.2. Provide the phenotypic ratios for the F₂ generation. (2)
 - 5.3. If Sello allows plant G to self-pollinate, give the phenotype and genotype of the offspring. (2)
- [6]

SECTION B: ADDITIONAL CONTENT NOTES

2. Introduction:

Genetics is a science. Genetics is the study of the principles of **heredity and variation**. A unique genetic code is found in the DNA of each organism and is passed on to the offspring during reproduction. Since there are **two parents** required for sexual reproduction, **genetic variation** will occur to ensure survival of the fittest.

The Role of Gametes in Inheritance



- DNA molecules on the chromosomes consist of sections called **genes**
- each gene contains the hereditary **traits**, e.g. skin and hair colour, height, body structure and blood group are represented by the genes on each of the two homologous chromosomes
- in the process of Meiosis, **haploid** gametes are produced and the gametes will contain one set of genes
- during fertilisation, the gametes fuse and a **diploid zygote** results
- one set of genes will come from the female parent and one set from the male parent
- the two sets of genes may be the same or different for a trait, e.g. the mother may have black hair and the father may have blonde hair
- the offspring inherits two sets of genes, **50% from the mother** and **50% from the father** and will, therefore, be different from each of the parents
- the **diploid zygote**, therefore, contains a **double set of DNA** and is a **combination** of both parents

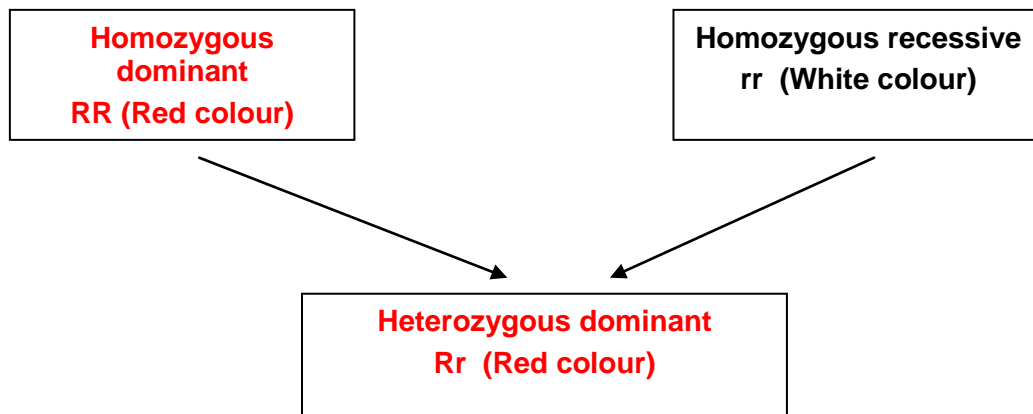
Genetic Terminology

Genetics is a science and specific terms are used. Make sure that you know and understand the following terms very well as they form the basis for ALL the genetics that you will study.

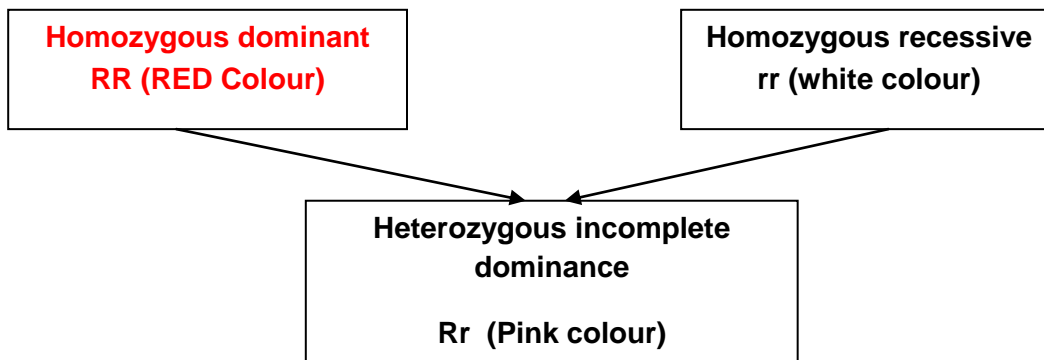
- **Locus:** This is the exact position or **location** of a gene on a chromosome.
- **Alleles:** A pair of genes that are located at the **same point** on each of the two **homologous chromosomes** and represent a specific trait – one from the father and one from the mother.
- **Homozygous:** *Homo* = same and *zygous* = zygote. When two alleles of a pair of genes are the **same** for one trait e.g.: both alleles are for red flowers, the cross will result in a **pure breed** for red.
- **Heterozygous:** Hetero = different and zygous = zygote. When two alleles of a pair of genes are **different** for a trait, e.g. one of the alleles is for red flowers and one is for white flowers, the cross will result in a mixture of the two genes called a **hybrid**.
- **Dominant trait:** A heterozygous offspring will display the dominant trait because it will **dominate** over the other recessive gene of the allele pair, e.g. red colour will **dominate over** the gene for white colour, so the offspring will look red.

The **dominant allele** is always written with a capital letter: **R** = red and **r** = white.

- **Homologous dominant alleles** means that both genes are the **same** for the same dominant trait. It will be represented by **RR**, which represents both the genes for red flowers. The offspring will be red because **two dominant genes** are present.
- **Heterozygous alleles** means that **one gene is dominant** and **one gene is recessive** for the same trait, e.g. red flowers. It will be represented by **Rr**, which represents one gene for red and one gene for white. The offspring will display red flowers, because red is **dominant** over white.

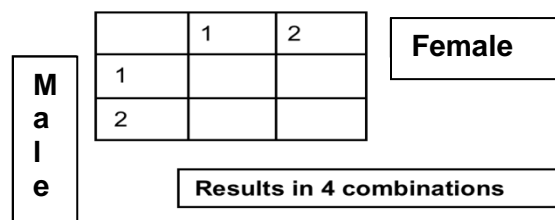


- **Recessive trait:** The recessive allele is the trait that **is dominated over** by the dominant gene. It is written with a small letter: r = white.
 - **Homologous recessive alleles** means that both recessive genes are the same, i.e. rr – two genes for are present for white flowers. The offspring will display the **recessive white** colour only. The recessive trait will only ever be seen when it is in the homologous state.
 - **Heterozygous alleles** means that the genes are different with one gene dominant (red colour) and one gene is recessive (white colour) represented by Rr . The offspring will display red flowers because red is **dominant** over white which is **recessive**.
- **Incomplete dominance:** when the dominant gene allele is not able to completely dominate over the recessive gene allele, a mix of the two genes results, e.g. red + white = pink. When the offspring is heterozygous with incomplete dominance, you will be able to see the combination of the two gene alleles traits:



- **Genotype:** This is the **genetic** composition of an organism and represents the information that is present in the gene alleles, for example RR , Rr , rr . You **cannot see this because it is in the genes**.
- **Phenotype:** This is the **physical** appearance of an individual, i.e. what you will see when you look at the offspring. The phenotype is determined by the genotype. You **will see** white flowers for rr , but you will see red flowers if the genotype is RR or Rr .
- **Monohybrid cross:** Mono = ONE so, when **one pair** of contrasting traits is crossed to determine the possible inheritance of the offspring. There will be 4 possible combinations that result from the cross:

2 possibilities from the male and 2 possibilities from the female ($2 \times 2 = 4$).



- **Dihybrid cross:** Di = TWO, so when **two pairs** of contrasting traits are crossed to determine the possible inheritance of the offspring. There will be **16 possible combinations** that result from the cross – 2 possibilities from the male and 4 possibilities from the female (4 x 4 = 16).
- **Filial generation:** The parents are represented by **P₁**. The parents reproduce to produce offspring that result from the cross. The offspring are the **first filial generation** and this is represented by **F₁**. When the offspring become mature and reproduce, they are represented by **P₂**. Their offspring will be the second filial generation represented by **F₂**.
- **Punnett square:** This is a schematic representation of a cross. Take careful note of the way the information is written. The example below: one parent is BB and the other is bb:

B = brown hair colour b = blonde hair colour

P₁ BB x bb

	gametes	b	b	<input type="checkbox"/>
<input type="checkbox"/>	B	Bb	Bb	
	B	Bb	Bb	<input type="checkbox"/>

F₁

Genotype: 4:4 Bb heterozygous offspring (always include the ratios)

Phenotype: 100% brown (always include the %)

SECTION C: HOMEWORK: (Taken from DoE Additional Exemplar 2008 Paper 1)

Learner Note: If you have difficulty with the homework questions, you should refer to the content notes, or refer to your class teacher for assistance.

QUESTION 1

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 F1 generation. Also give the phenotypes of the F1 generation. [8]

QUESTION 2

Learners want to investigate eye colour in fruit flies (*Drosophilamelanogaster*). 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 F1 generation for eye colour may be obtained. [6]

SECTION D: SOLUTIONS TO SECTION A**QUESTION 1**

- 1.1 D
 - 1.2 C
 - 1.3 B
 - 1.4 B
 - 1.5 C
 - 1.6 A
 - 1.7 C
- [7]

QUESTION 2

- 2.1 A
 - 2.2. C
 - 2.3. A
 - 2.4. B
 - 2.5. D
 - 2.6. D
 - 2.7. C
 - 2.8. D
- [8]

QUESTION 3

P₁ phenotype Black x Brown✓
 genotype Bb x bb✓

Meiosis

G B, b x b ✓

Fertilisation

F₁ genotype Bb and bb✓
 phenotype Black and brown✓

OR

gametes	b	b
B	Bb	Bb
b	bb	bb

1 mark for correct gametes
 1 mark for correct genotypes

1 mark for stating **P₁ AND F₁**✓ (must have both)

1 mark for stating **meiosis AND fertilisation** ✓ (must have both) (Any 6) **[6]**

QUESTION 4

- 4.1 (a) homozygous dominant✓and heterozygous✓ (2)
- (b) homozygous recessive✓ (1)
- 4.2 Normal is dominant and the dominant condition✓ can show up in either homozygous or heterozygous state✓ (2)

OR

To have a normal child ✓the person must have at least one dominant gene✓/phenotype is normal (2)

[5]

QUESTION 5

5.1 Plant A - YY✓ Plant B - yy✓ (2)

5.2 Yellow: green ✓
 = 3 : 1 ✓ (2)

5.3 Phenotype – green peas ✓
 Genotype – yy✓ (2)

[6]

SELF STUDY TOPIC 1: CONSOLIDATION EXERCISE - MEIOSIS AND DNA

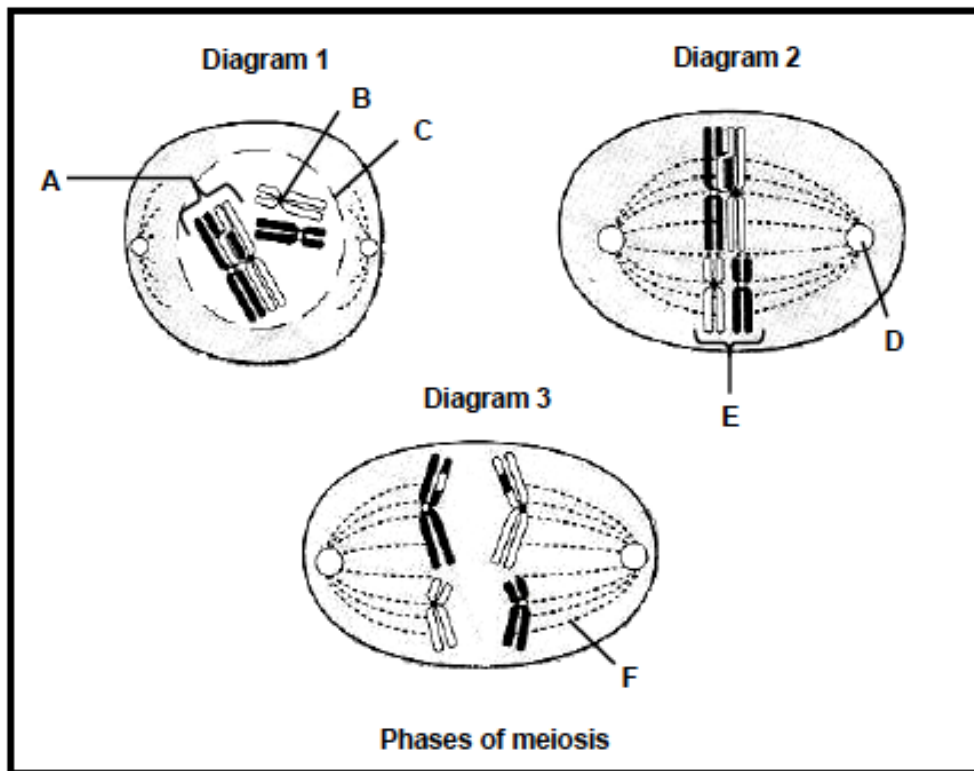
Learner Note: Please take careful note of the time allocation. You will only be allowed the specific time allocated, to complete each question. When there are diagrams, remember that you must always first write in the labels that you know, onto the diagrams before answering the questions that follow below. Underline important information that is given to you in the question. Remember to underline the words that indicate what the question is asking. Take careful note of the mark allocations.

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: 13 minutes (Taken from DoE Additional Exemplar 2008 Paper 1)

The diagrams below represent phases of meiosis.

(Remember to label the diagram first before going on to the questions.)



- 1.1 Name the process taking place at A. (1)
- 1.2 Identify structures B, C, D and E. (4)
- 1.3 State ONE function of F. (2)
- 1.4 What phase of meiosis is represented in Diagram 2? (2)
- 1.5 Give a reason for your answer to QUESTION 1.4. (2)
- 1.6 How many chromosomes are shown in Diagram 3? (1)
- 1.7 Name ONE organ in the human female body where the process of meiosis will occur. (1)

[13]

QUESTION 2: 7 minutes (Taken from DoE Additional Exemplar 2008 Paper 1)

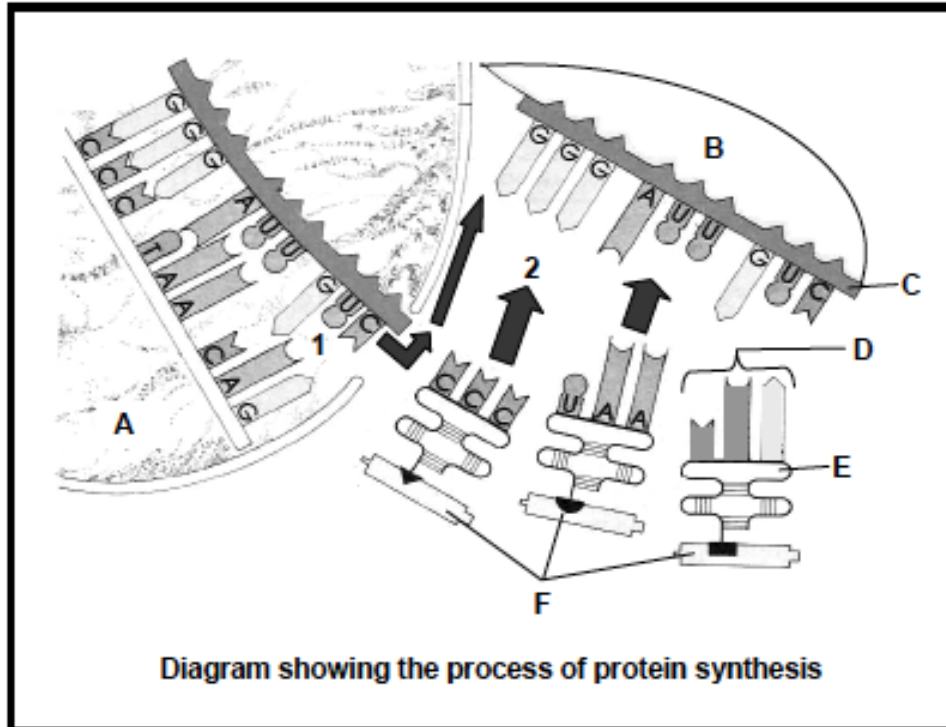
Tabulate THREE differences between DNA and RNA.

(Remember to give your table a suitable heading/caption. Compare the same characteristics for each of the columns.) [7]

QUESTION 3: 10 minutes (Taken from DoE Additional Exemplar 2008 Paper 1)

Study the diagram below which shows the process of protein synthesis.

(Remember to label the diagram first and then move onto the questions.)



- 3.1 Identify organelles A and B respectively. (2)
- 3.2 Label structures C, E and F respectively. (3)
- 3.3 Which stage of protein synthesis is represented at:
 (a) 1? (1)
 (b) 2? (1)
- 3.4 Write down the anticodon that reads from left to right at D. (3)
- [10]

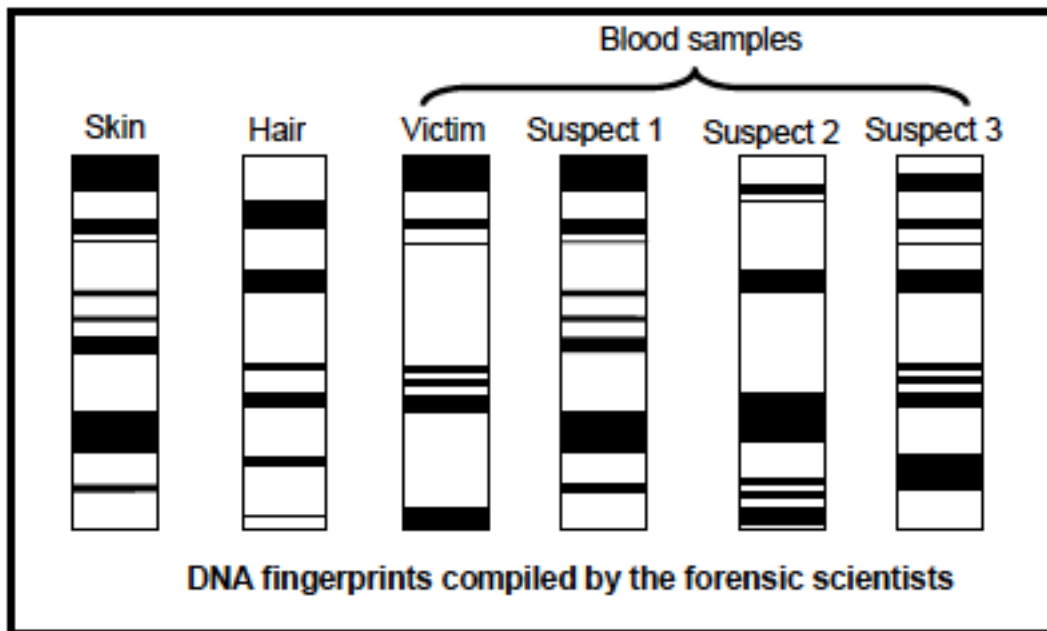
QUESTION 4:**10 minutes***(Taken from DoE Exemplar 2008 Paper 1)*

A woman was found stabbed to death in a hotel. The police found a few strands of hair in her one hand. There was also skin tissue under her long nails.

Forensic scientists took blood samples from three suspects to compile DNA fingerprints. DNA fingerprints were also compiled from the victim's blood and the hair and skin tissue found in the victim's hands.

The following diagram shows the DNA fingerprints of the hair sample, the skin tissue sample and blood from the victim and the three suspects.

(Remember to use a ruler horizontally so that you do not make a mistake when comparing the VNTR markers.)



- 4.1 Did the DNA from the hair and skin tissue come from the same person? (1)
- 4.2 What conclusion can you make from QUESTION 4.1 about the possible number of people involved in the murder? (2)
- 4.3 Which of the three suspects might have been involved in the murder? (1)
- 4.4 Give a reason for your answer to QUESTION 4.3. (1)
- 4.5 Do you think that the DNA evidence on its own is enough to convict a suspect? (1)
- 4.6 Give a reason for your answer to QUESTION 4.5. (2)
- 4.7 Explain whether the collection of DNA from every citizen in South Africa to create a DNA fingerprint database is a good idea or not. (2)

[10]

SELF STUDY TOPIC 2: CONSOLIDATION EXERCISE - MEIOSIS AND HUMAN FINGERPRINTING

Learner Note: The consolidation exercises have been extracted from past examination papers to assist you to assess yourself, and to assist you with exam techniques and time allocation. Please ensure that you adhere to the time allocations. We suggest the following:

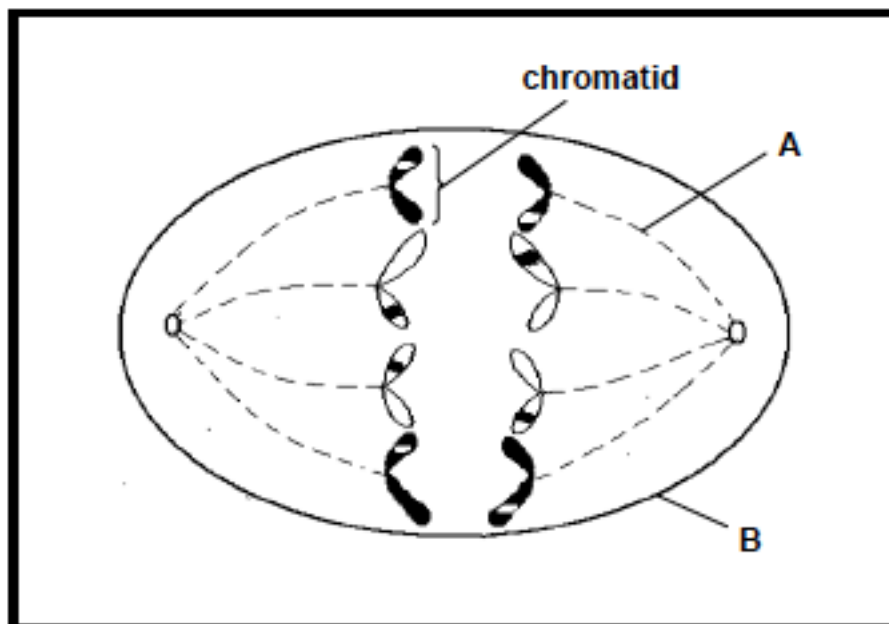
- Read through the question first.
- Check the important words and underline these words.
- Take careful note of the marks per question, then start the question and the time.
- After the allocated period, stop and begin to go through the next question and follow the same process.
- If you have not completed a question, you must complete it when your teacher works through the memo.
- You will lose the marks for the questions that you have not completed.
- You **MUST** work fast but correctly.

SECTION A: TYPICAL EXAM QUESTIONS

EXERCISES: 60 minutes including going through the memo.

QUESTION 1: 13 minutes

The diagram below represents an animal cell in a phase of meiosis.



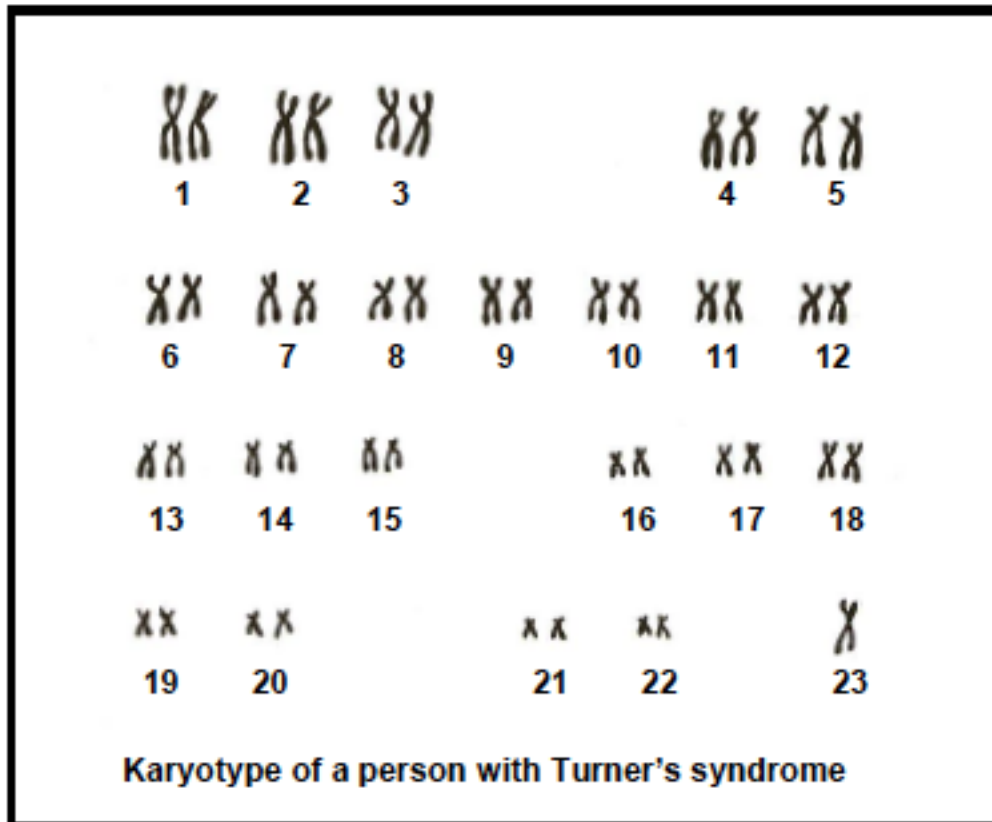
Remember to complete the labels before you move on to the questions.

- 1.1 State which **phase of meiosis** is represented in the diagram above. (1)
- 1.2 Give a reason for your answer to QUESTION 1.1. (2)
- 1.3 Identify parts A and B. (2)

- 1.4 How **many chromosomes** ...
- (a) were present in the parent cell **before** it underwent **meiosis**? (1)
- (b) will be present in each cell at the **end** of the **meiotic division**? (1)
- 1.5 State **ONE** place in the body of a human **female** where meiosis would take place. (1)
- 1.6 Could the cell represented in the diagram be that of a **human**? (1)
- 1.7 Explain your answer to QUESTION 1.6. (2)
- 1.8 Give **TWO reasons** why meiosis is **biologically important**. (2)
- [13]

QUESTION 2: 4 minutes

Study the karyotype below of a person suffering from Turner's syndrome. Females with Turner's syndrome do not develop mature sex organs.

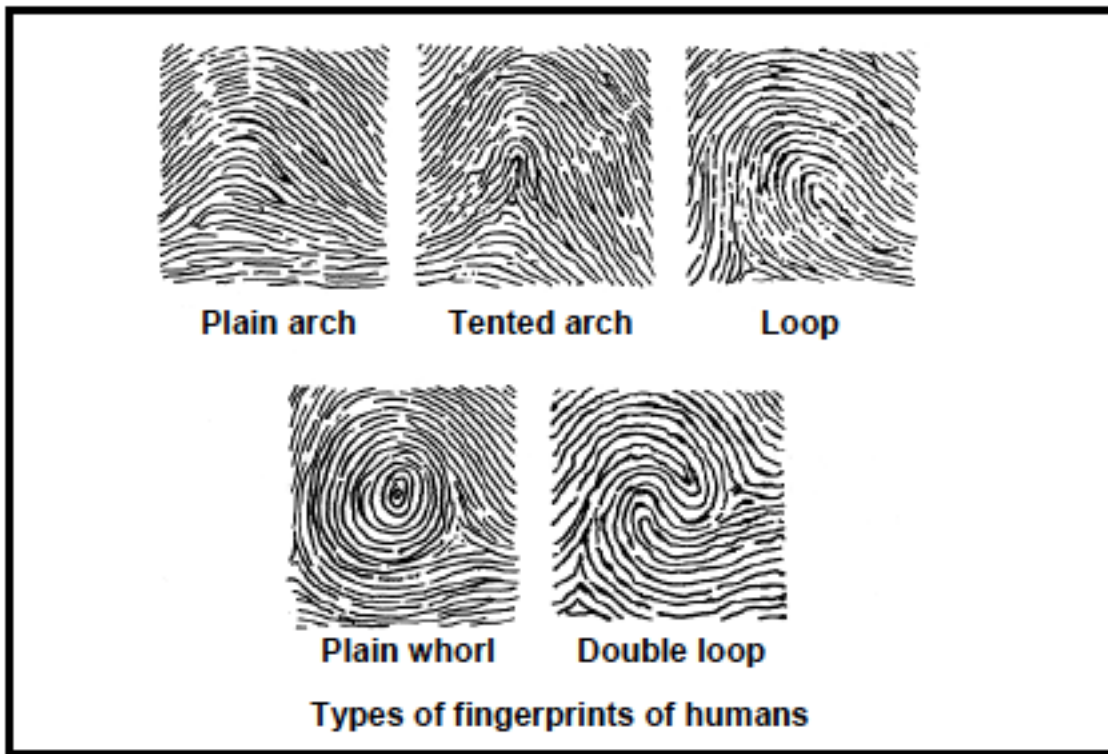


Remember: there are 44 autosomes and only one X chromosome. Chromosome pair 23 is the sex chromosomes: in males XY and in females XX normally.

- 2.1 State the **differences** between the karyotype for a **normal female** and a female with **Turner's syndrome**. (2)
- 2.2 Explain **ONE effect** of the disorder in a female. (2)
- [4]

QUESTION 3: 13 minutes

Humans show differences in characteristics such as fingerprints. Humans have **five main types** of fingerprints as shown in the diagram below:



A fingerprint is a useful way of **identifying people** and **classifying** them into groups. A fingerprint is taken by rolling the right index finger onto an ink pad and then onto a piece of paper.

During a discussion of this topic, a group of learners asked the following question: "Which one of the five main types of fingerprints is **most common** amongst the learners of this school?"

- 3.1 State any **FOUR steps** in the planning process that must be considered when **planning an investigation** to answer the question above. (4)
- 3.2 The learners carried out an investigation and the results are shown in the table below.

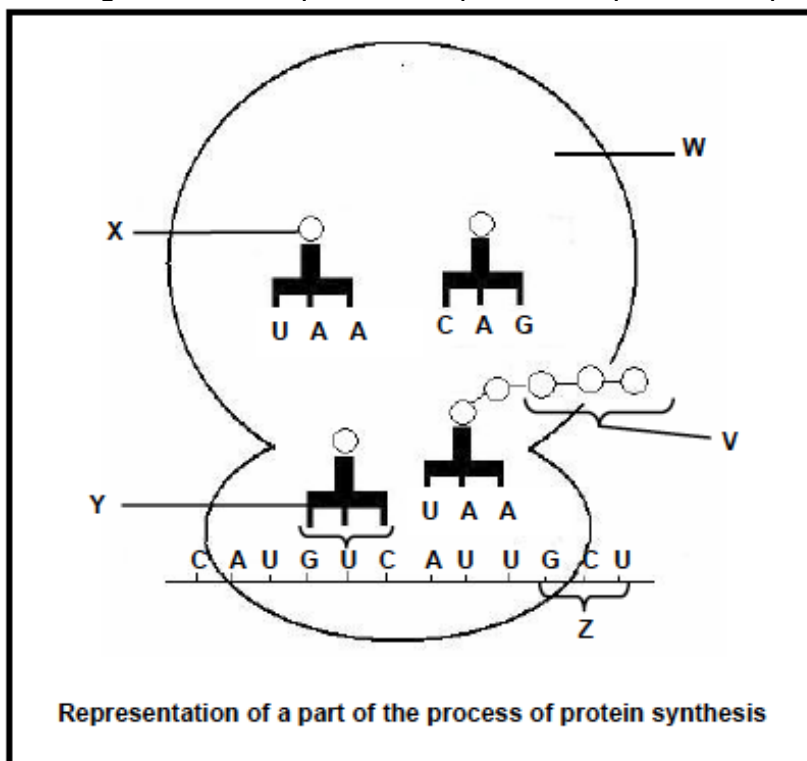
Main types of fingerprints	Number of learners
Plain arch	123
Tented arch	112
Loop	124
Plain whorl	150
Double loop	50

- (a) Give a **caption** for the table. (2)
(Remember that a caption is a heading where the words ‘types of fingerprints’ and ‘learners’ would have to be included since these are the headings of the two columns.)
- (b) Learners came to the following conclusion:
Most learners have the plain arch-type fingerprint.
 Is this a valid conclusion? (1)
(Remember that validity is based on the numbers, the accuracy and similar conditions like ages, males/females as applicable, etc.)
- (c) Give a reason for your answer to QUESTION (b). (2)
- 3.3 State the following:
- (a) **TWO advantages** of having a fingerprint database of every citizen and visitor in South Africa (2)
- (b) **TWO disadvantages** of having a fingerprint database of every citizen and visitor in South Africa (2)

[13]

QUESTION 4: 9 minutes

The diagram below represents a part of the process of protein synthesis.



- 4.1 Name the part/**stage of protein synthesis** that is illustrated in the diagram above. (1)
- 4.2 Name the organelle labelled W. (1)

4.3 The table below shows the base triplets of mRNA that correspond to the different amino acids.

mRNA	AMINO ACID
CAU	histidine
AUU	isoleucine
GUC	valine
CUU	leucine
GCU	alanine
CCU	proline
CGA	arginine

With reference to the diagram in QUESTION 4 above:

- Name the amino acid labelled X. (1)
- State the base sequence of the molecule labelled Y. (1)
- What **collective name** is given to the triplet of mRNA bases that correspond to each amino acid? (1)
- How would the **composition** of the protein molecule change if the base sequence at Z was CGA instead of GCU? (2)

4.4 Use the information in the table to write the **DNA base sequence** that would correspond with the amino acid **histidine**. (2)
[9]