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.**

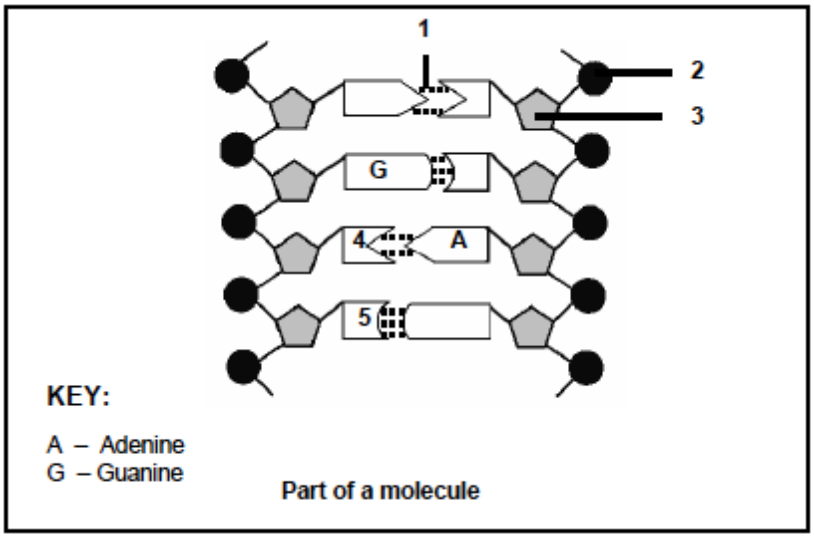
SECTION A: TYPICAL EXAM OUESTIONS

QUESTION 1: – 16 minutes *(Taken from DoE Exemplar 2008)*

HINTS for Question 1.

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.



Part of a molecule

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.

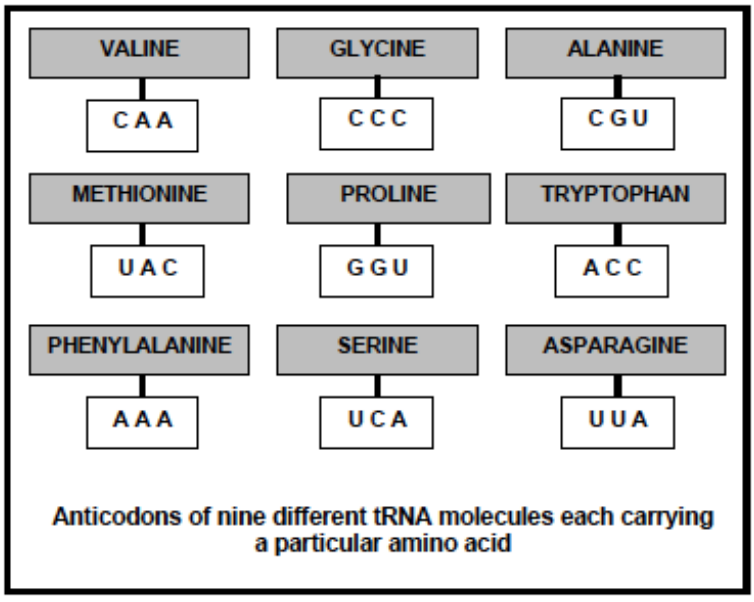
GTT — ATG — TGG

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)



Anticodons of nine different tRNA molecules each carrying a particular amino acid

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)

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)

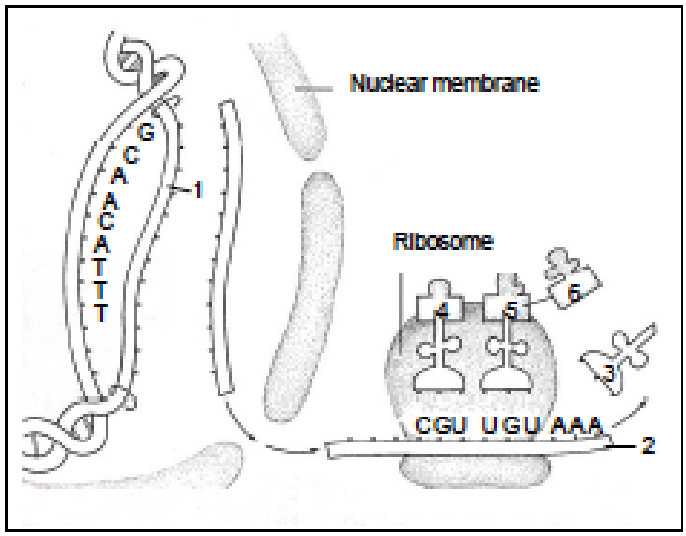
2.4 The following is a sequence of base triplets in DNA: **GAA - GTA - TTT - AAA**

(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 inDNA changes. (1)

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)

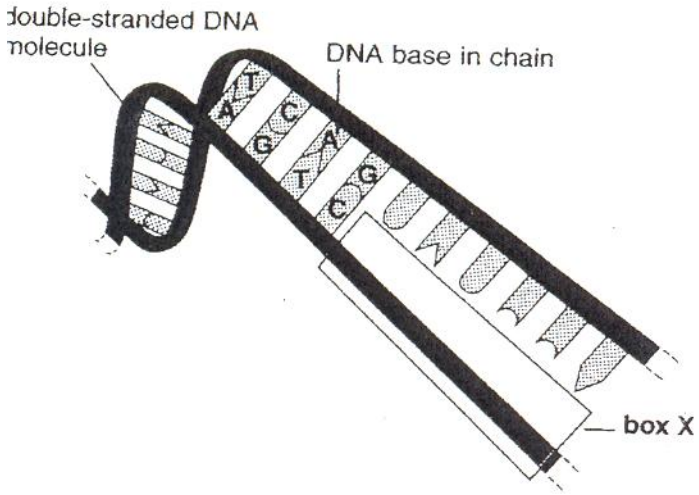
3.2 Using the letters of the genetic code, write down the complementary nitrogenous bases on strand 1 of the DNA double helix, starting from the top. (3)
(Remember: A=T/U and G=C)

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)

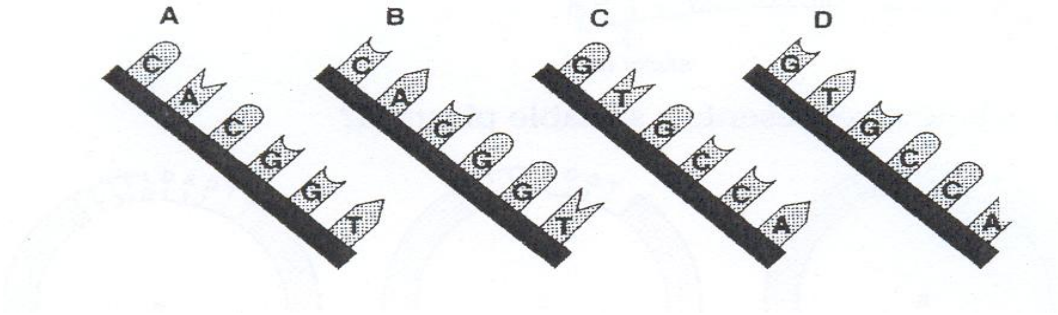
THE RELATIONSHIP BETWEEN tRNA AND AMINO ACIDS DURING PROTEIN SYNTHESIS	
tRNA anticodons	Amino acid
UGU	threoline
CGU	alanine
UUU	lysine
ACA	cysteine
GCA	arginine
GUU	glutamine
CUA	aspartate
CCA	glycine
AAA	phenylalanine

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. One of her egg cells could contain the following genes:

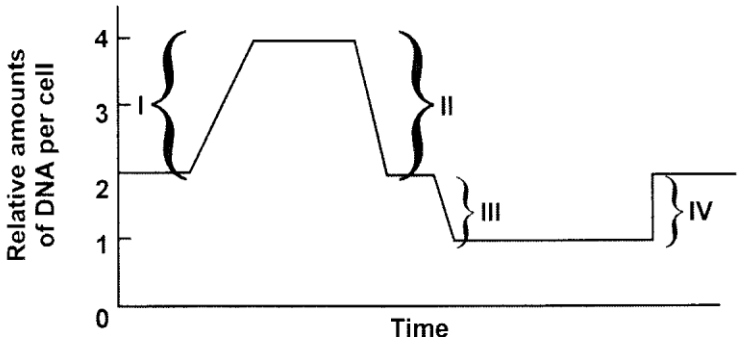
A abd

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

(7x2=14)

4.4 In analyzing 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 (5)

SECTION B: SOLUTIONS

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)

(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)

1.2.2 CAA√UAC√ACC√ (in sequence) (3)

1.2.3 Phenylalanine√ Valine√Methionine√ (in sequence) (3)

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)

4.1 A
4.2 C
4.3 A
4.4 C
4.5 B (1 x 5 = 5)

SECTION C: ADDITIONAL CONTENT NOTES

1. Intoduction:

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 contain 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.

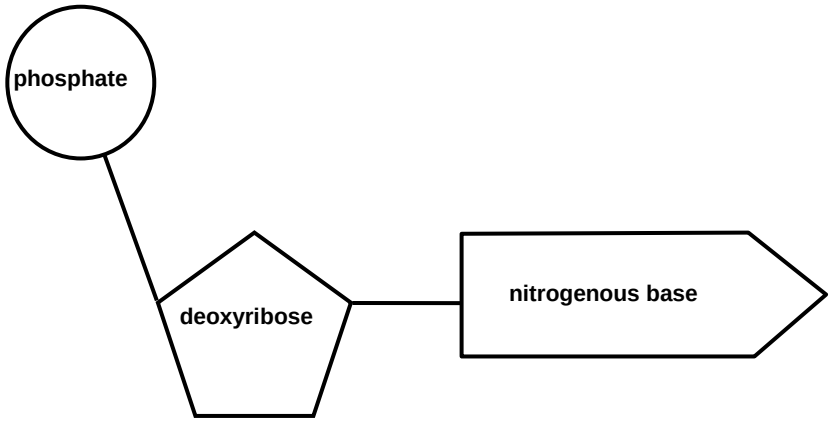
- **DNA** - deoxyribose nucleic acid and
- **RNA** - ribose nucleic acid.

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:

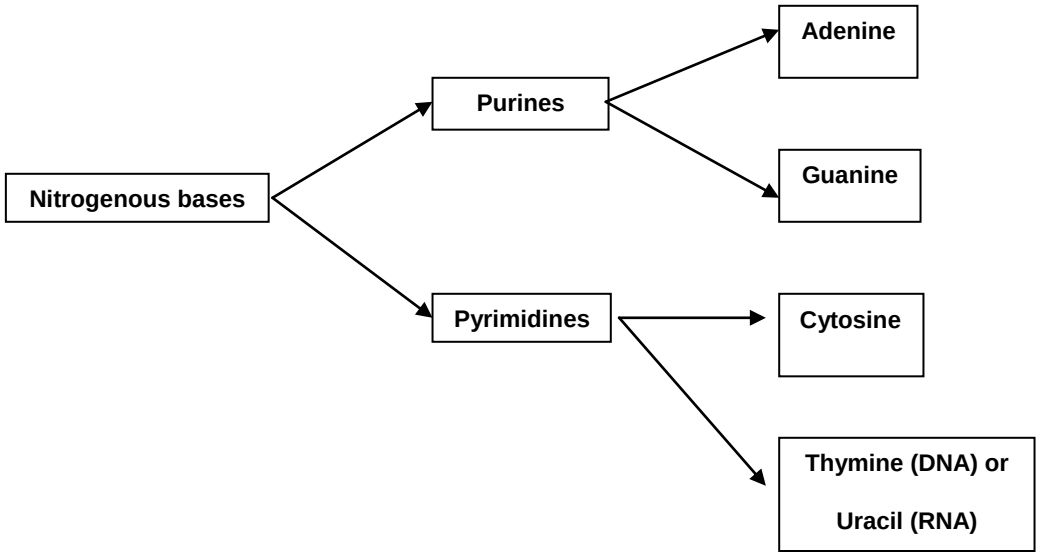
- 1 phosphate ion
- 1 pentose sugar
- 1 nitrogenous base



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:

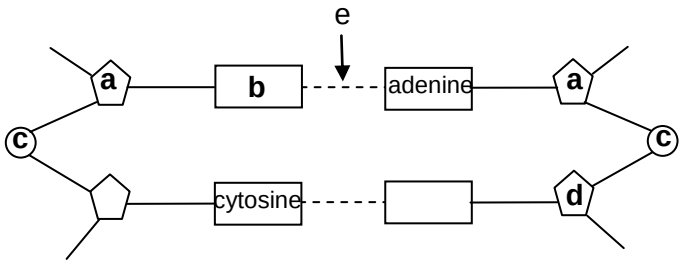
- Messenger RNA (mRNA): mRNA is formed by the DNA as a piece of three nitrogenous bases called a triplet or codon. The process is called transcription.
- Transfer RNA (tRNA): each tRNA collects a specific amino acid from the cytoplasm, depending on the order of the nitrogenous bases and carries it to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

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

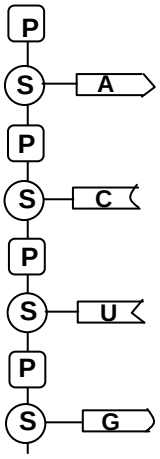
SECTION D: HOMEWORK EXERCISE *(Taken from Viva Life Science Grade 12)*

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. (1)
(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)

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)

SECTION E: SOLUTIONS TO HOMEWORK SESSION 8:

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

(Although you will only be asked to discuss the advantages of GMO's, please make sure that you know 4 advantages and 4 disadvantages because you may be asked to answer either advantages or disadvantages, or a combination of both in an exam)

Advantages of using GMO's as a source of food

- Increased yield of food✓ to prevent hunger/starvation✓
- Increased vitamin/mineral/nutrient✓ content of food to improve human health✓
- Produce oil with less saturated fat✓/lower caffeine level to improve human health✓
- Increased shelf life✓ of plant products reducing food spoilage✓/ minimising waste
- Control pests✓ by inserting genes instead of using chemicals thus reducing harm to the environment✓
- Produce crops resistant to disease✓/pests/drought, thus increasing their yield/decreasing production costs✓
- Cheaper✓ to produce hence lowering the cost of food✓
- Selecting genes that delay production✓/ripening of fruits to meet the demand locally and internationally✓
- Enhance the taste✓ of food for increased marketability✓

(Mark first SIX only) any (6 x 2) (12)

ASSESSING THE PRESENTATION OF THE ESSAY:

Marks	Descriptions
3	Well structured – demonstrates understanding of question
2	Minor gaps in the answer
1	Attempted but with significant gaps in the answer
0	Not attempted/nothing written/nothing correct other than question number

(3)

(15)

(The mark allocation for the Synthesis part of the essay type question will be standard for all essay type questions in your examinations. Take note of the mark allocation.)