

RNA & PROTEIN SYNTHESIS

6 FEBRUARY 2013

Lesson Description

In this lesson, we will look at:

- The DNA profiling (finger-printing) with respect to the following:
 - The concept of DNA profiling
 - Its use in forensics
 - Costs, ethical considerations and consequences of interpretation errors.
- Location and functions of mRNA and tRNA
- Structure of RNA as single stranded and consisting of nucleotides, each made up of a sugar (ribose), phosphate and nitrogen base
- 4 nitrogenous bases of RNA: adenine (A), uracil (U), cytosine (C), guanine (G)
- Similarities and differences between DNA and RNA
- Protein Synthesis – Where? How? Why?
- Gene Mutations
- DNA Sequences

Key Concepts

DNA Profiling

- Every human being, with the exception of identical twins, has a unique sequence of bases in their DNA. Each individual – **unique DNA** – used to identify people.
- Technique used - **genetic profiling/DNA fingerprinting**
- Sources - **body tissue like saliva, blood, skin, semen or hair.**



All the hair samples we found at Crime Scene belong to you, detective...



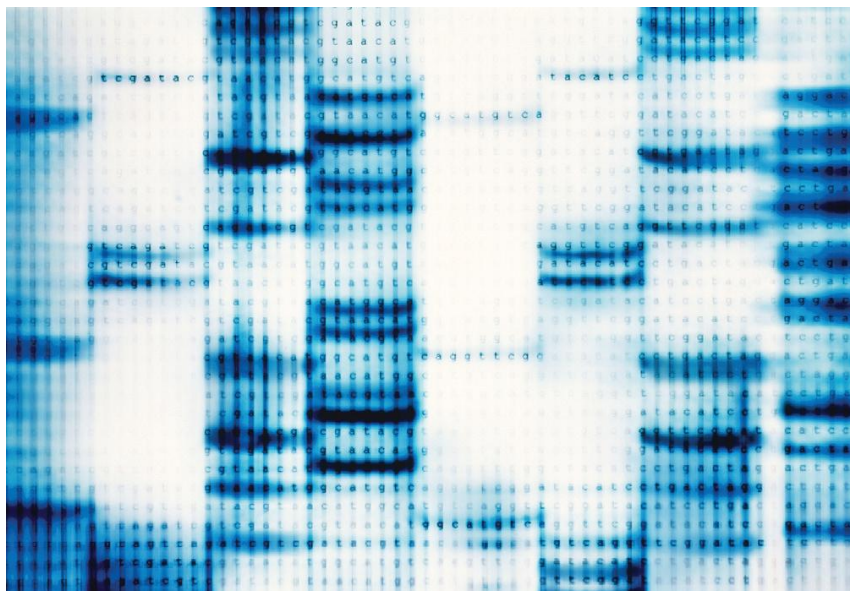
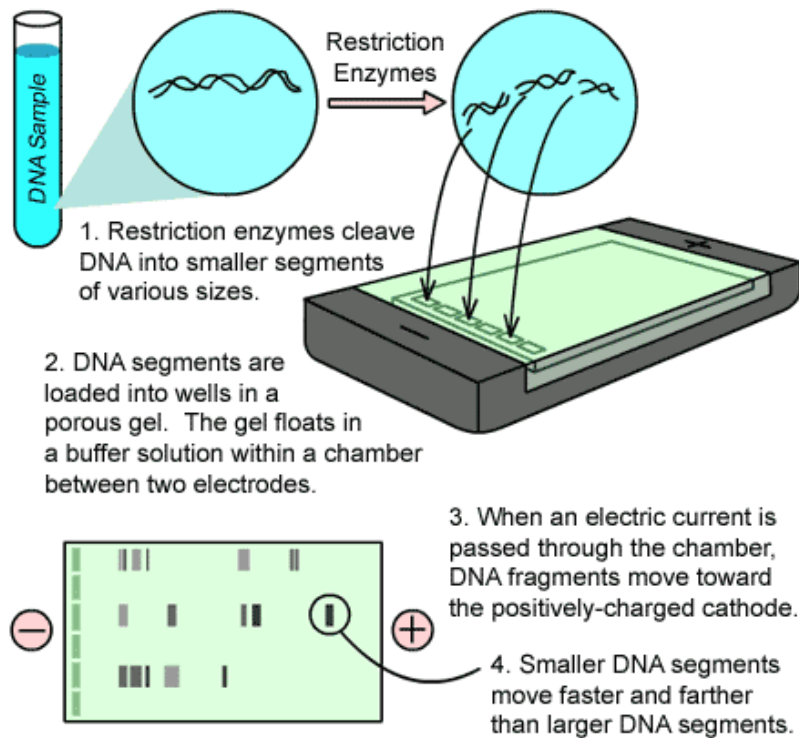
Yeah...
Actually, I have
got this hair
loss problem...

Brainstuck.com



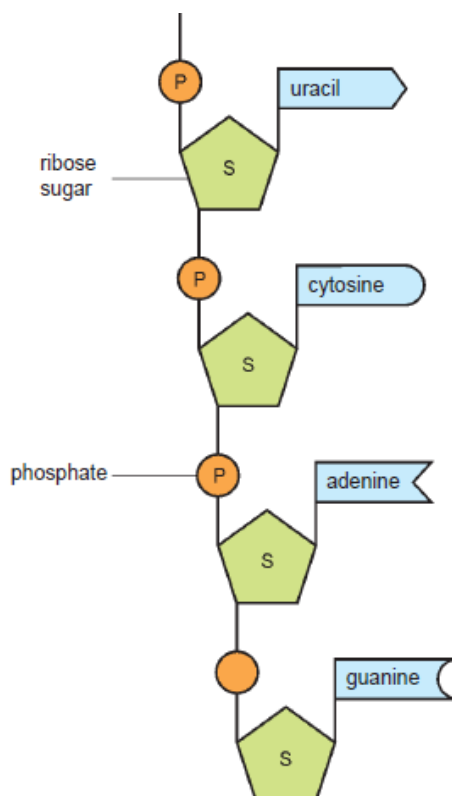
This is how we get a DNA fingerprint:

Figure S-2: Gel Electrophoresis



The Structure of RNA

- RNA - Single-stranded polynucleotide.
- The nucleotides of RNA differ slightly from those of DNA. An RNA nucleotide consists of:
 - A **ribose** sugar
 - A phosphate
 - One of four bases: Either **uracil**, cytosine, guanine or adenine.



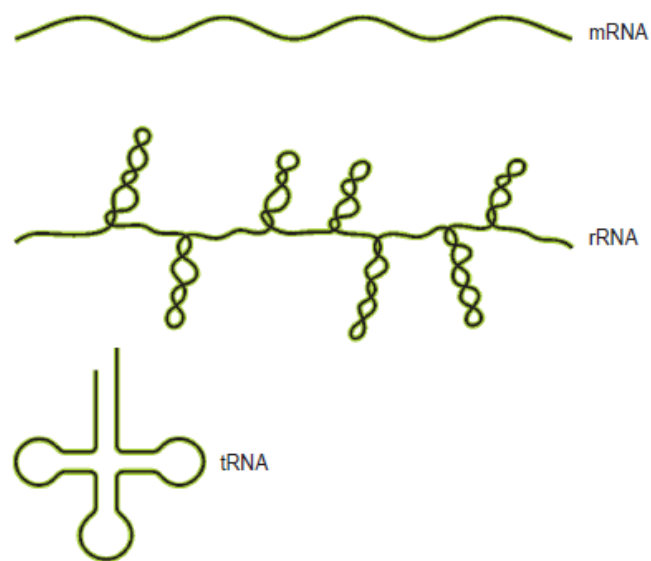
(Structure of RNA from Life Sciences for all, Grade 12, Figure 4.14, Page 193)

Types of RNA

RNA is manufactured by DNA. There are three types of RNA.

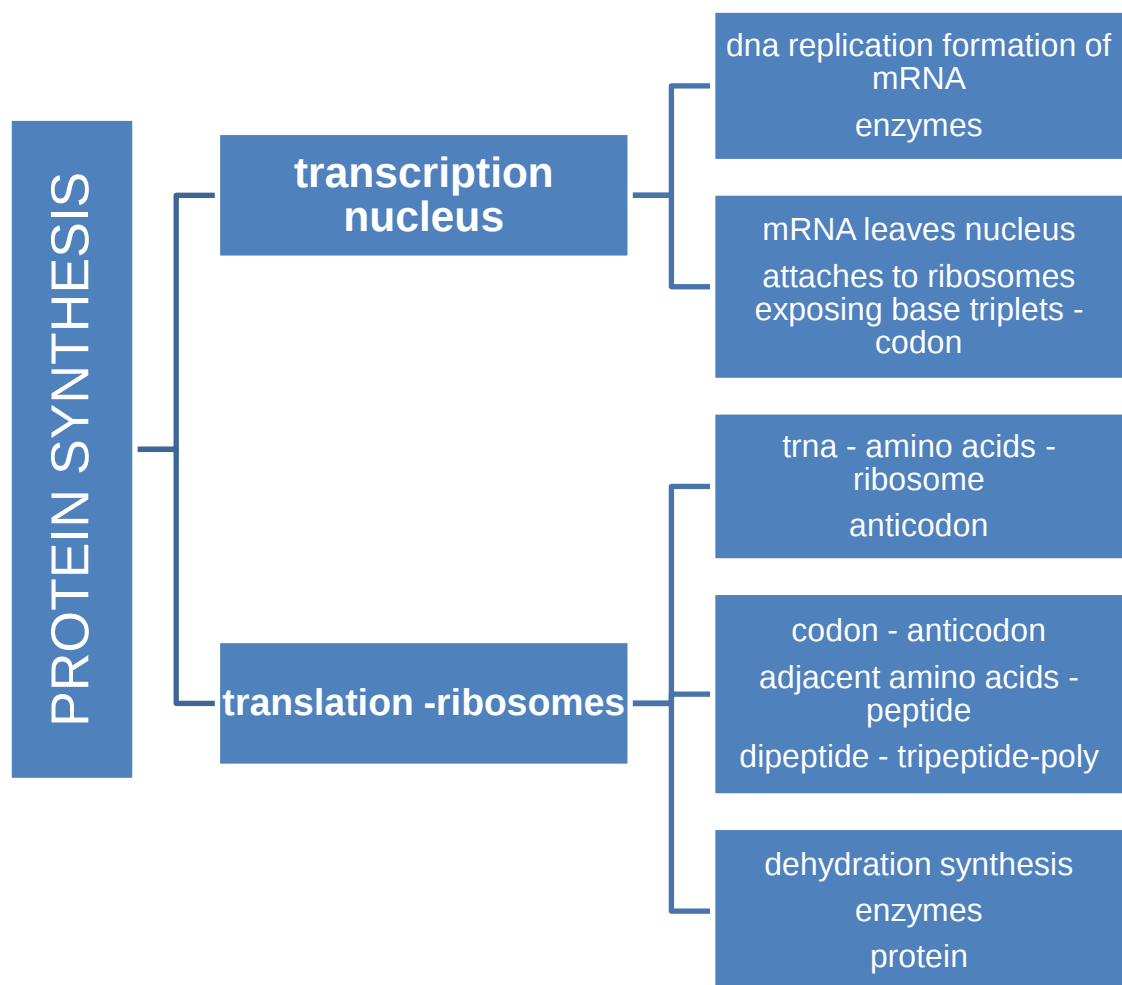
The three types of RNA:

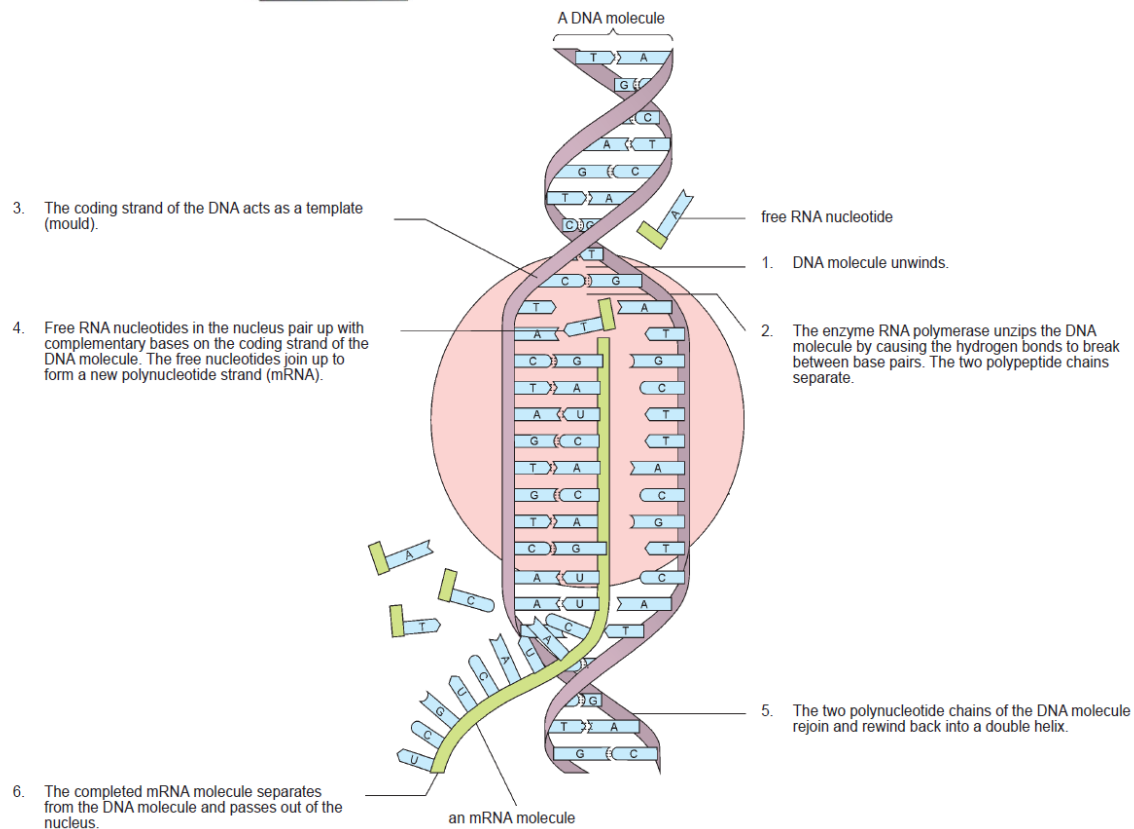
1. Messenger RNA (mRNA). It carries information about the amino acid sequence of a particular protein from the DNA in the nucleus to the ribosome where the protein will be made.
2. Ribosomal RNA (rRNA) has no precise shape. It forms the ribosomes, which are found in the cytoplasm of the cell, that make proteins.
3. Transfer RNA (tRNA) is a small molecule with a cloverleaf shape. It picks up amino acids in the cytoplasm and brings them to the ribosomes where they are joined together to form a protein.



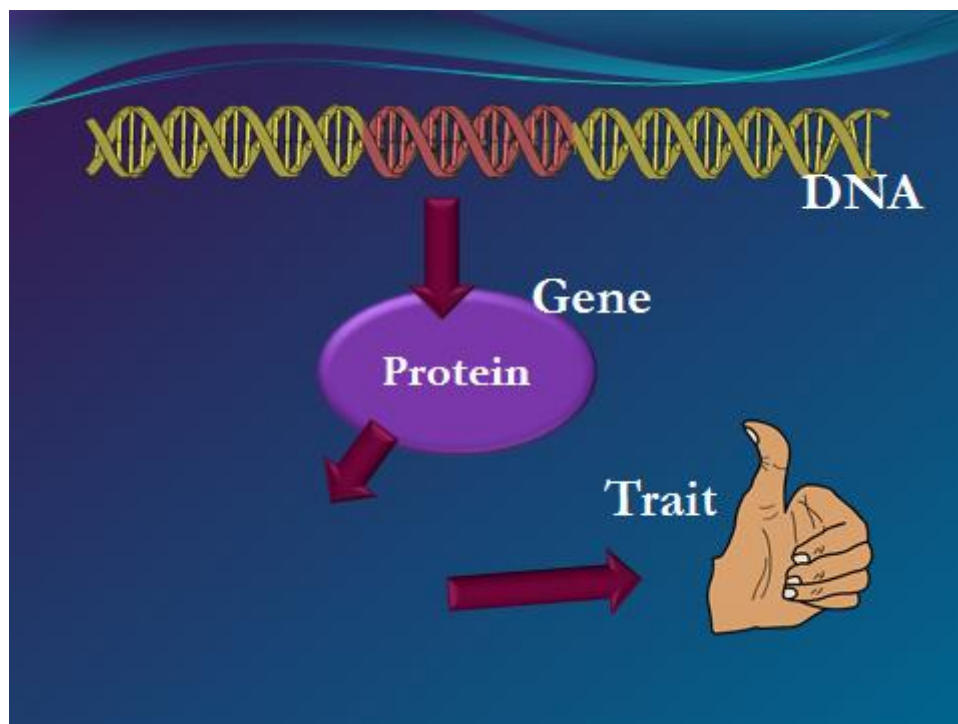
(The Three Types of RNA from Life Sciences for all, Grade 12, Figure 4.15, Page 193)

Protein Synthesis





(Transcription from *Life Sciences for all*, Grade 12, Figure 4.16, Page 194)



Mutation

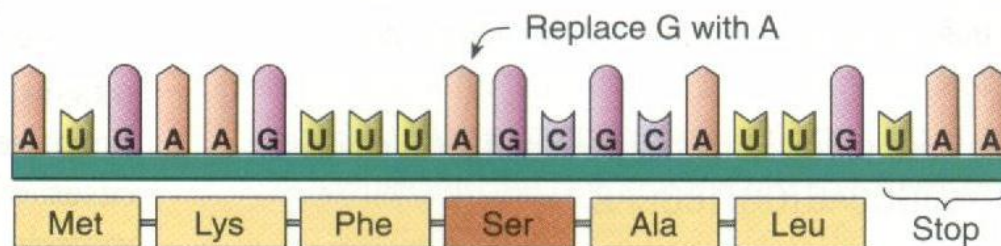
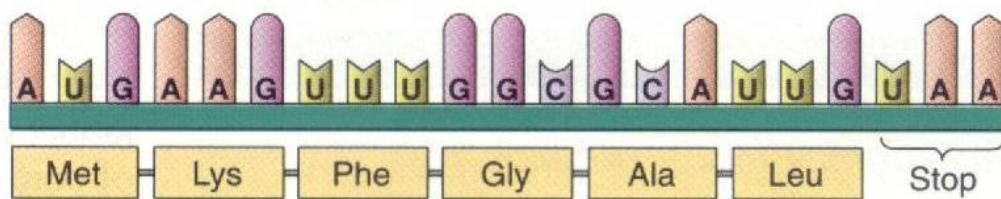
- A **mutation** is a change in the DNA or chromosome of an organism.
- Gene mutation – change in DNA or gene
- Chromosomal – change in larger sections of the chromosomes

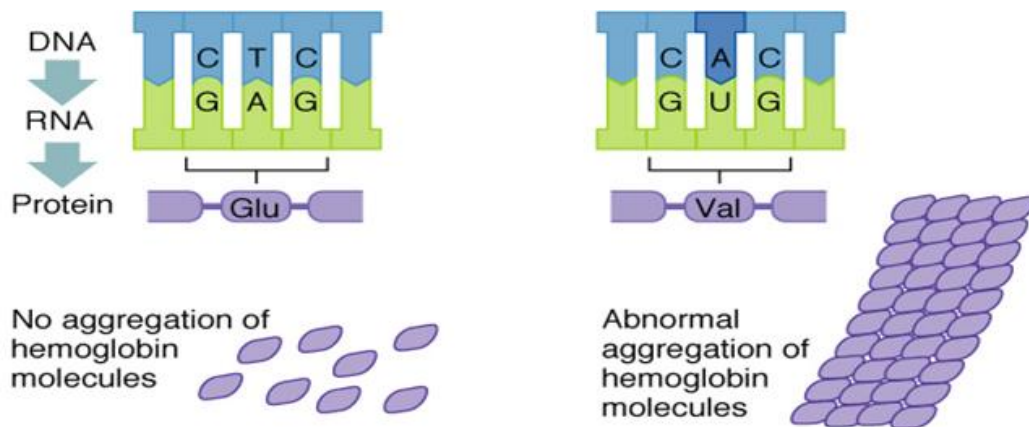
Causes

- Spontaneous
- Environmental factors
- UV light
- X-rays
- Chemicals, e.g.: Benzene, formaldehyde, carbon tetrachloride
- Causal agents known as **MUTAGENS**

Gene Mutation Types:

Point:





Normal red blood cells



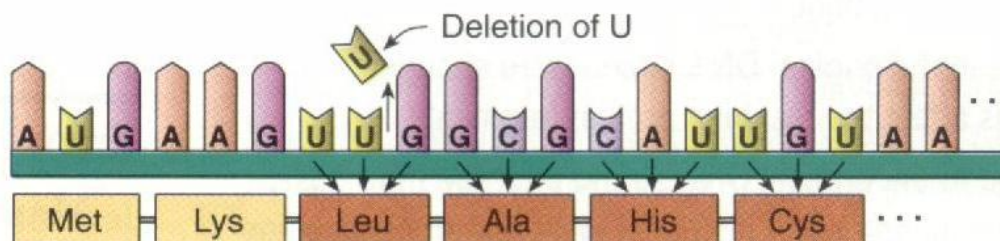
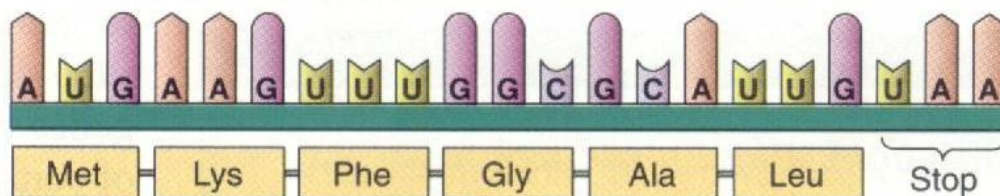
a.

Sickled red blood cells



b.

Frameshift Mutations:



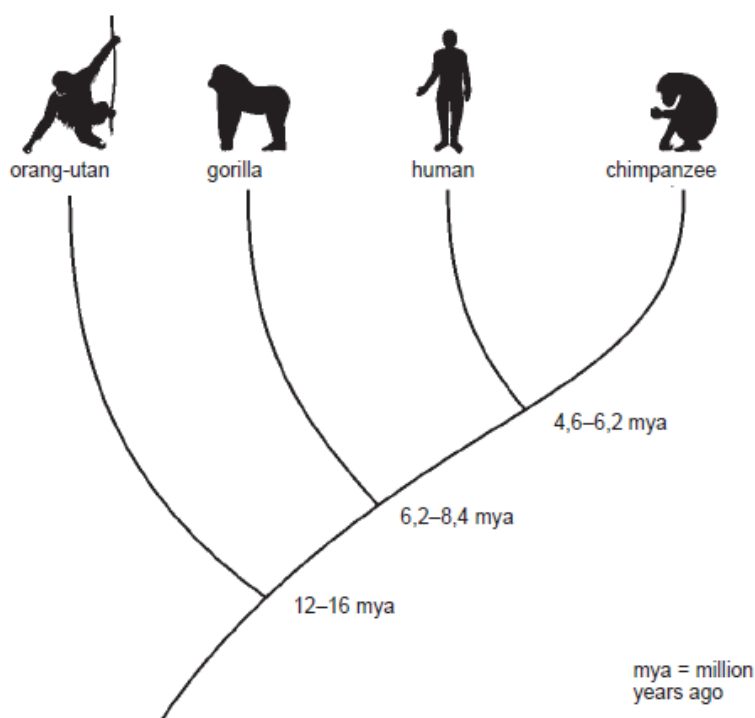
- Adding or deleting one base of DNA molecule will change every amino acid in the protein after the addition or deletion.

- All organisms have the same method of passing on **hereditary information** from one generation to the next. They all use DNA.
- The greater the similarity between the sequences of bases in the DNA from two different people, the closer their biological relationship is.
- We can also compare the sequence of bases in the DNA of two different species to find out how closely they are related.

Table showing the percentage difference in the DNA between different species and humans and the times that the different species and humans separated from a common line of descent

Primate species	Difference in the DNA between this species and humans (%)	Separation of this species and the humans line (million years ago)
Gorilla	1,62	6,2 to 8,4
Chimpanzee	1,24	4,6 to 6,2
Orang-utan	1,63	12 to 16

(The data in the table is based on research carried out by Feng-Chi Chen of the National Tsing Hua University in Taiwan and Professor Wen-Hsiung Li of the University of Chicago in the USA.)



(Phylogenetic tree showing the evolution of great apes and humans from Life Sciences for all, Grade 12, Figure 4.32, Page 207)

Questions

Question 1

Give the correct biological term for the following:

- the nitrogenous base which is found in RNA but not DNA
- a triplet of three bases found on an mRNA
- the single strand of DNA that contains the instructions for making a protein
- the type of RNA that picks up amino acids in the cytoplasm and brings them to the ribosomes
- factors that cause mutations in DNA and chromosomes
- the synthesis of mRNA from DNA.

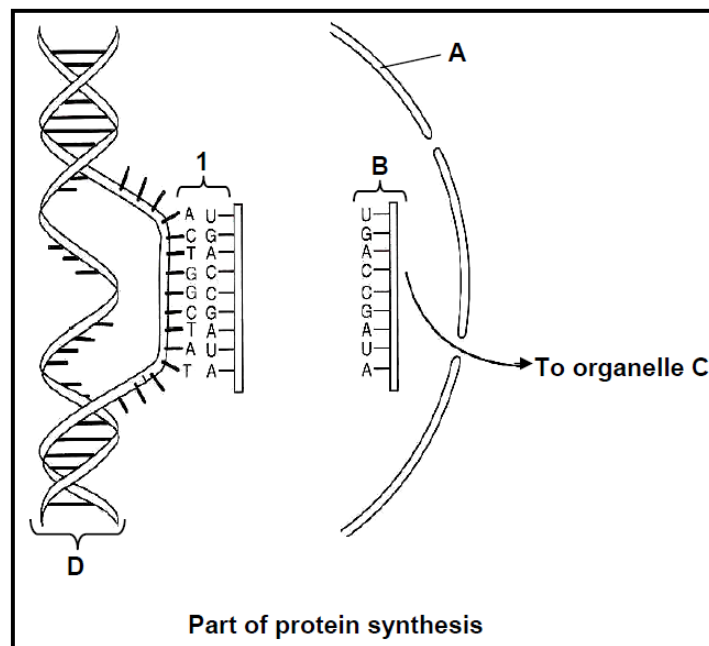
Question 2

Tabulate the differences between DNA and RNA

Question 3

(Adapted from March 2010, DOE, P1, Question 2.2)

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



- Provide labels for structures A, B and D respectively. (3)
- State ONE function of molecule D. Which part of protein synthesis takes place at 1? (1)
- Which part of protein synthesis takes place at 1? (1)
- Name the type of proteins that control the process named in QUESTION (c). (1)
- Identify organelle C. (1)
- Name and describe the part of protein synthesis that takes place at organelle C. (6)

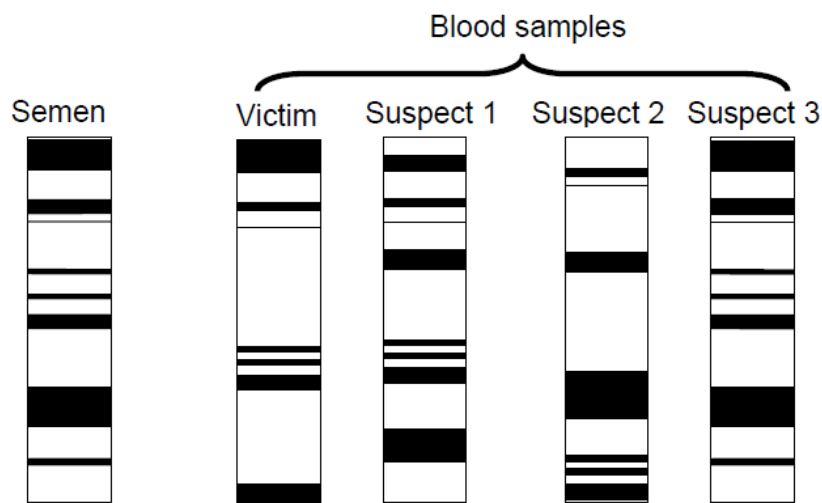
Question 4

(Adapted from March 2010, DOE, P1, Question 2.3)

Study the diagram below which shows the following DNA profiles/genetic fingerprints:

- Blood of a raped female victim
- Blood of three suspects
- Semen found on the female victim

- Which suspect was most likely the rapist? (1)
- Explain your answer to QUESTION (a) . (2)
- Give ONE reason why this evidence may be considered reliable. (1)
- Give TWO reasons why this evidence may not be considered reliable. (2)
- Name TWO benefits of DNA profiling other than for solving crimes. (2)



DNA profiles compiled by forensic scientists

Question 5

(Adapted from Exemplar 2011)

Describe how proteins are formed in a cell and explain the impact of the two types of gene mutations on the formation of proteins.

(20)