2024 JC1 H2 BIOLOGY DECEMBER REVISION PACKAGE

NAME: …… CLASS: ……

Topic: CELLULAR STRUCTURES AND FUNCTION

Question 1 [6 marks] TJC Prelims 2009

The electron micrograph in Fig. 1.1 shows an acinar cell found in the pancreas.

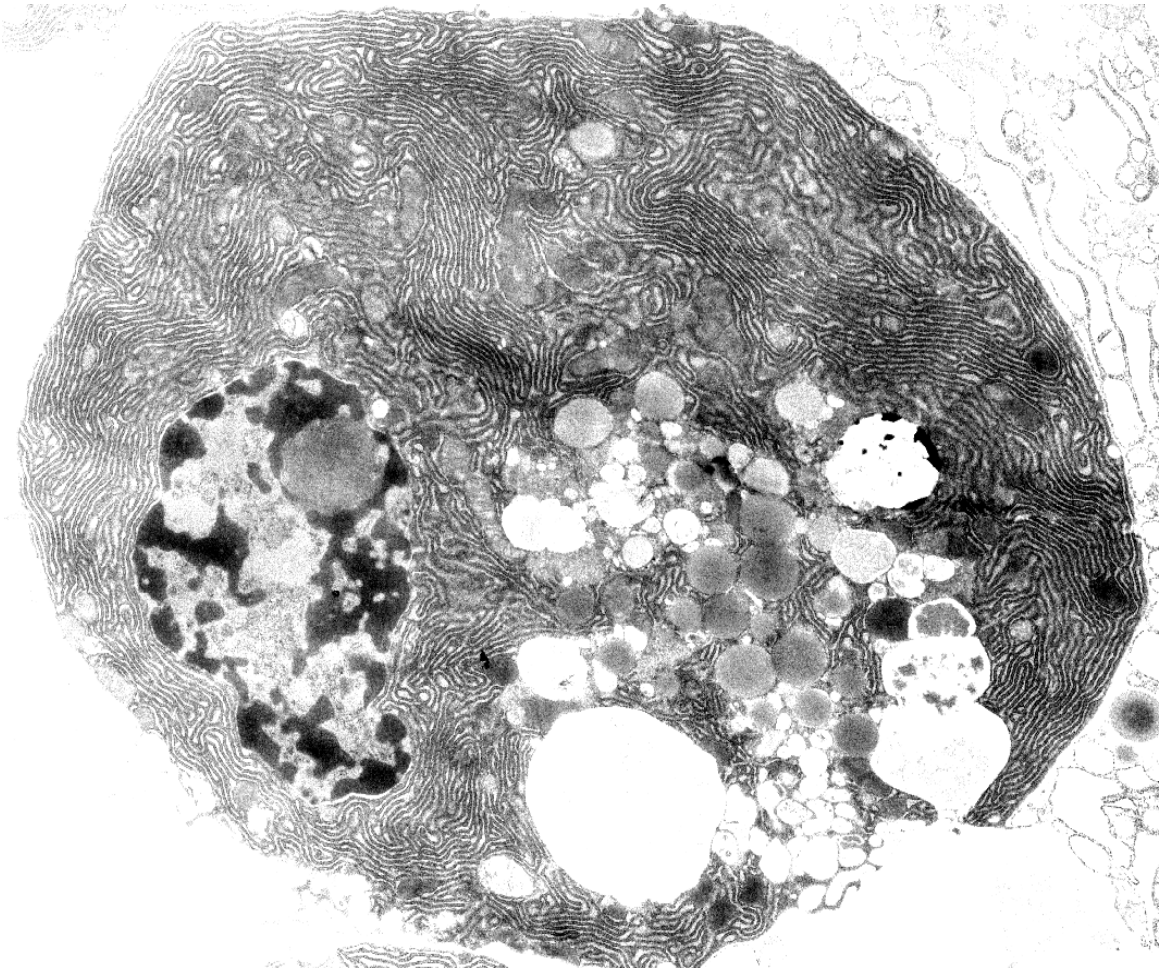


Fig. 1.1

(a) With reference to Fig. 1.1, suggest the principal function of the pancreatic acinar cell. Give two reasons to explain your answer. [3]

Fig. 1.2 shows two different structures, A and B, found in an animal cell.

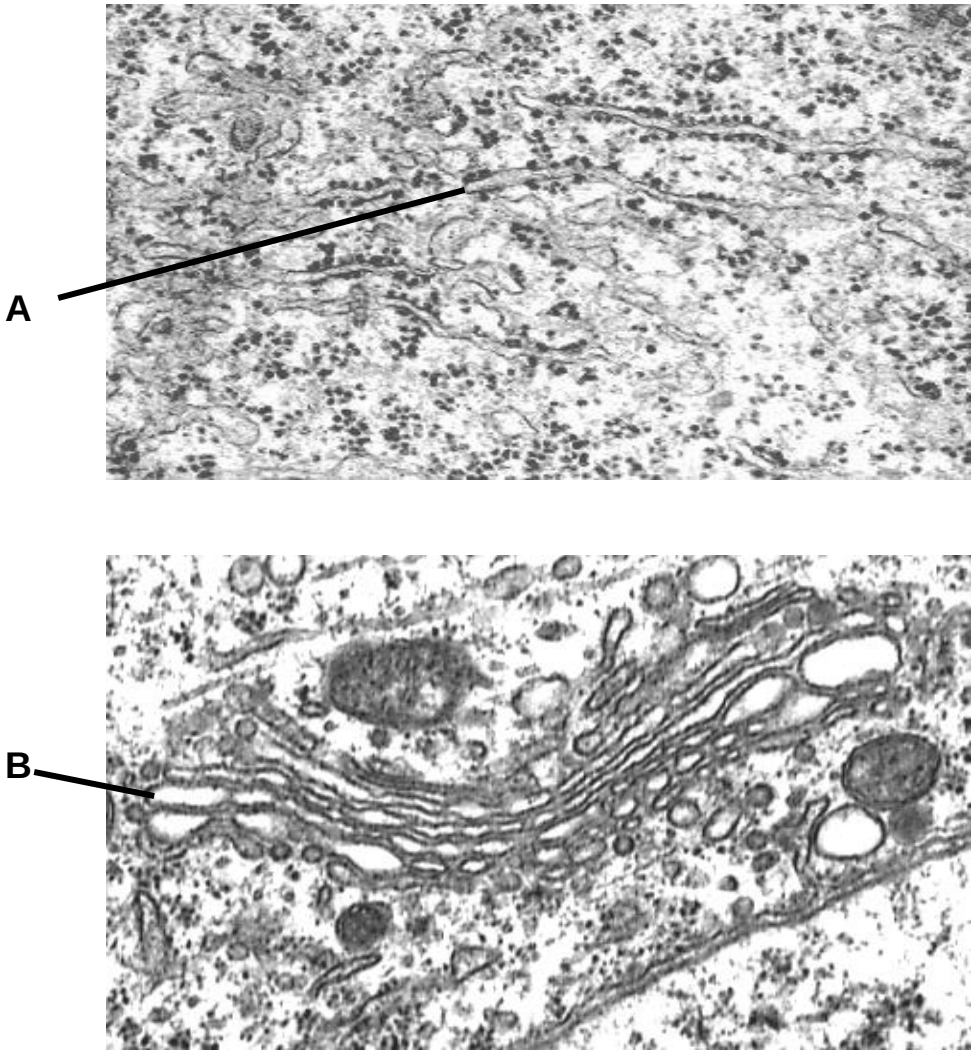


Fig. 1.2

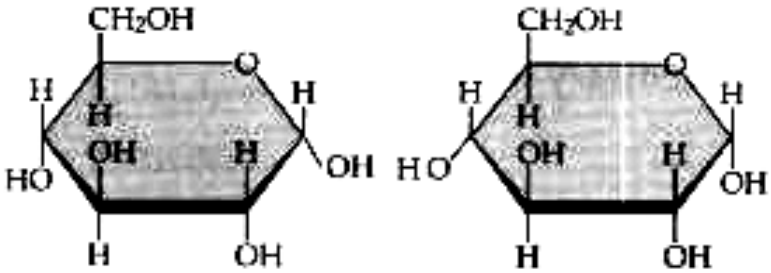
(b) (i) Describe two ways in which A is similar to B. [2]

(ii) The products of B are usually in the inactive form. Suggest the significance of this. [1]

Topic: BIOMOLECULES AND CELL MEMBRANE

Question 2 [11 marks]

The figure below shows two molecules of glucose.



(a) Draw the resulting maltose molecule arising from a dehydration reaction. [1]

(b) Label the resulting bond. [1]

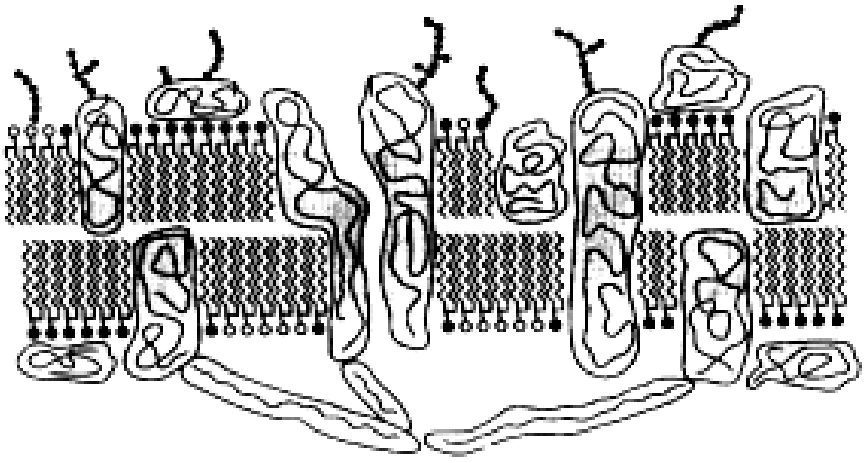
Starch, a storage molecule in plants, is a polymer made of glucose molecules joined together. It consists of two components.

(c) Name these two components. [2]

(d) (i) Give one similarity between these two components. [1]

(ii) Give two differences between these two components. [2]

(f) The following figure shows a section of a cell surface membrane.



(i) Explain why membranes are described as fluid mosaic in structure. [2]

(ii) Some molecules are able to pass through the plasma membrane without the facilitation of transport proteins. Describe the unique properties of these molecules. [1]

(iii) Outline two other roles of membrane proteins apart from their role in transport. [2]

Topic: ENZYMES

Question 3 [7 marks] JJC Prelims 2009

Meat is the muscle of an animal. When animals are slaughtered, biochemical changes occur in the muscles, resulting in the hardening of meat. There are several ways to make the meat tender again, and these usually involve the partial breaking down of the proteins that make up the muscle tissue.

One way is to add the protein-digesting enzyme, papain, just before freezing the meat. As the meat is thawed and cooked, this enzyme digests the protein.

(a) Suggest how the protein may be held in the active site of a papain while the reaction occurs. [2]

(b) Use your knowledge of enzymes to explain:

(i) Why the rate at which protein is digested increases as the meat warms up in the early stages of cooking. [2]

(ii) Why protein digestion stops once the meat has been heated to 90^{o}C. [3]

Question 4 [6 marks]

The juice from freshly pressed apples is often cloudy. This cloudiness can be cleared by using the enzyme pectinase.

A student carried out an investigation into the action of pectinase on the cloudy juice from freshly pressed apples.

Four test-tubes were set up with different contents as follows:

Test-tube	Contents
1	10cm^3 apple juice + 1cm^3 pectinase solution
2	10cm^3 apple juice + 1cm^3 distilled water
3	10cm^3 distilled water + 1cm^3 pectinase solution
4	10cm^3 apple juice + 1cm^3 boiled pectinase solution

Each test-tube was shaken thoroughly and then placed in a water bath that are maintained at 40^{o}C for 60 minutes.

At regular intervals, samples were taken from each test-tube and tested to measure the percentage of light that passed through the sample. The percentage transmission of light was plotted on a graph.

Fig 4.1 shows the graph obtained for test tube **1** and **4**.

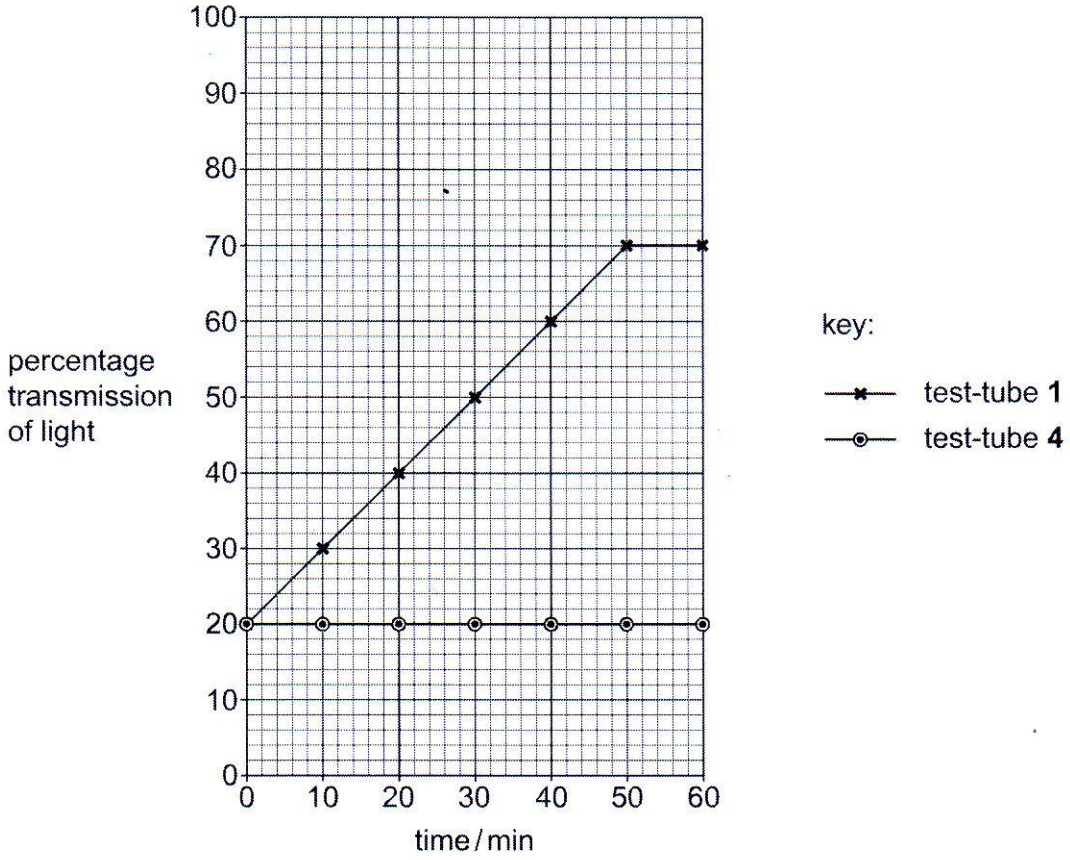


Fig 4.1

(i) Using the information in Fig 4.1, describe and explain the results obtained for test tubes **1** and **4**. [3]

(ii) Explain why test-tube **2** was included in the experiment. [2]

(iii) Sketch on the graph the results you would expect for test-tube **3**. [1]

Topic: CELL AND NUCLEAR DIVISION

Question 5 [10 marks]

Fig. 5.1 below shows nuclear division occurring in an animal cell.

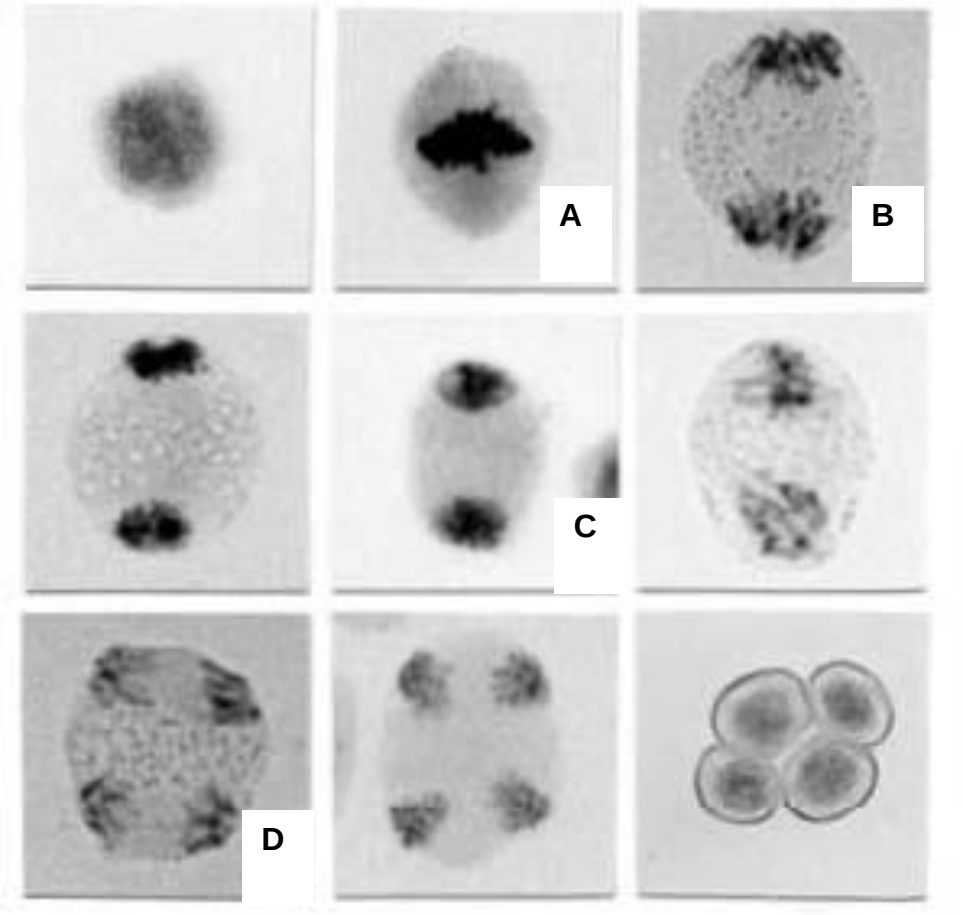


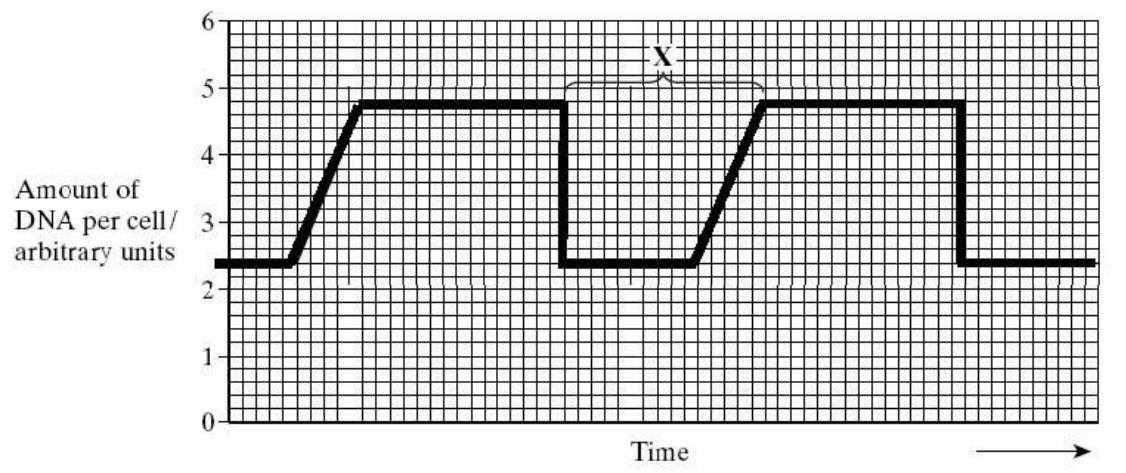
Fig. 5.1

(a) (i) Identify stages A to D. [2]

(ii) State the type of nuclear division shown in Fig. 5.1 [1]

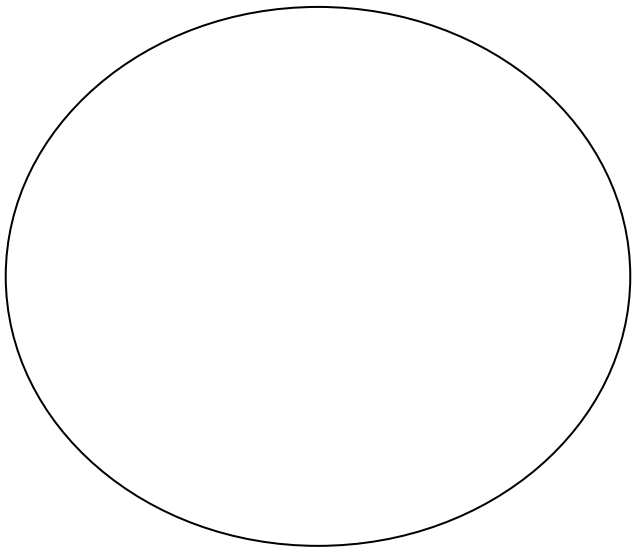
(iii) Explain your answer to part (ii). [1]

The graph below shows the relative amounts of DNA per cell during two successive cell divisions in a plant.



(b) Describe the events occurring at X. [3]

(c) Draw the behaviour of the chromosomes undergoing anaphase II during nuclear division in the cell given below where (2n = 6). [3]



Topic: DNA REPLICATION

Question 6 [12 marks] ACJC Prelims 2010

The herpes simplex virus is an enveloped DNA virus. Viral DNA enters the nucleus of the host cell via the nuclear pores and directs synthesis of viral RNA and DNA. The virus is able to grow in non-dividing cells because its genome encodes enzymes such as viral DNA polymerase and thymidine kinase. Thymidine kinase is involved in synthesising dexoyribonucleotides required for DNA replication.

(a) Describe the normal function of nuclear pores. [2]

(b) Explain the importance of DNA replication prior to mitosis. [2]

(c) Describe the importance of complementary base pairing in DNA replication. [2]

(d) Explain why synthesis of DNA occurs both continuously and discontinuously during DNA replication. [2]

(e) Acyclovir is an anti-viral drug which is used to treat herpes. It prevents the complete replication of viral DNA by viral DNA polymerase. The structure of acyclovir is shown below in Fig. 9.1.

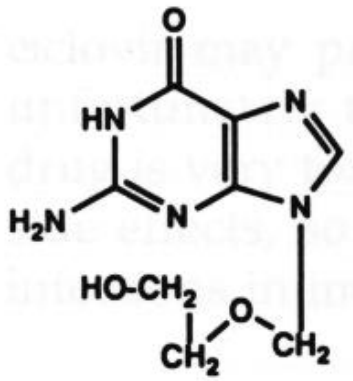


Fig.9.1

When acyclovir enters the infected cell, it is first phosphorylated by thymidine kinase and subsequently becomes further phosphorylated by host cell kinases. When this phosphorylated acyclovir is incorporated into the newly-synthesised DNA strand, it prevents further elongation of the DNA strand.

(i) With reference to Fig. 9.1, suggest how the incorporation of the phosphorylated acyclovir prevents further elongation of the DNA strand. [2]

(ii) Some strains of herpes simplex virus are now resistant to acyclovir. Suggest how the virus has gained resistance to this anti-viral drug. [2]

Topic: PROTEIN SYNTHESIS

Question 7 [10 marks]

Fig. 10.1 below shows an overview of the synthesis of proteins based on the genetic information contained in the nucleus in a plant cell.

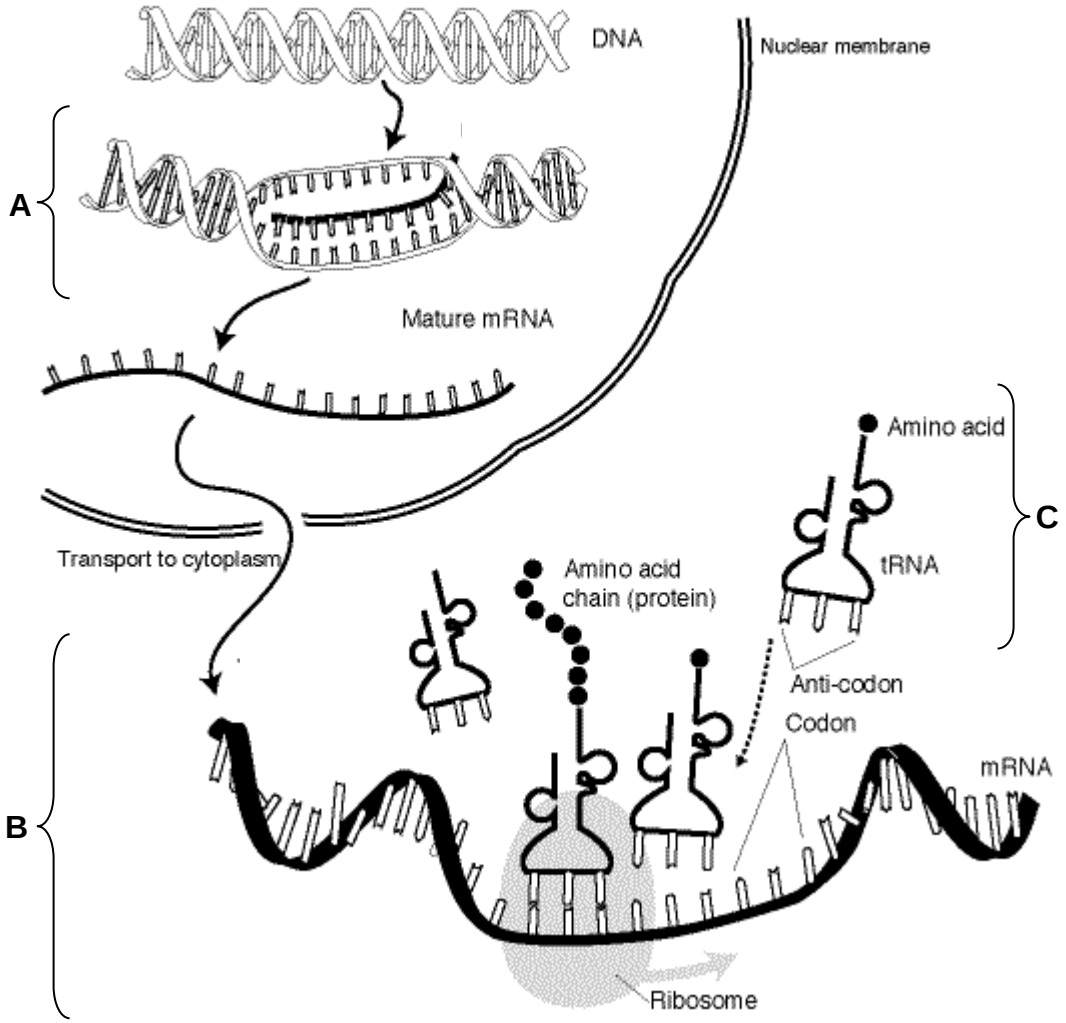


Fig. 10.1

(a) Label processes A and B. [1]

(b) In order for process A to occur, the DNA double helix must first be unzipped by enzymes. In vitro, DNA strands can also be separated by heat – denaturation of DNA.

(i) Explain how DNA is denatured by heat. [1]

Two DNA segments are shown below.

CTAGCTGAACGCGCCCGATT	TAAGCTTAACGCGACTGATA
GATCGACTTGCGCGGGCTAA	ATTCGAATTGCGCTGACTAT
Segment 1	Segment 2

(ii) Identify the segment that would require a higher temperature for denaturation of the DNA. Explain your answer. [2]

(c) Process A and DNA replication require different enzymes and substrates. Describe two other differences between these two processes. [2]

(d) In all cells, there are many types of structure C. State the minimum number of types that should be present and explain your answer. [2]

(e) Based on Fig. 10.1, explain how protein synthesis in *Agrobacterium tumefaciens* would differ from that of a plant. [2]

Topic : CONTROL OF EUKARYOTIC GENE EXPRESSION

Question 8 [5 marks] NJC Prelims 2009

Fig. 11.1 shows the activation of transcription initiation in eukaryotes by recruitment of the eukaryotic RNA polymerase II holoenzyme complex.

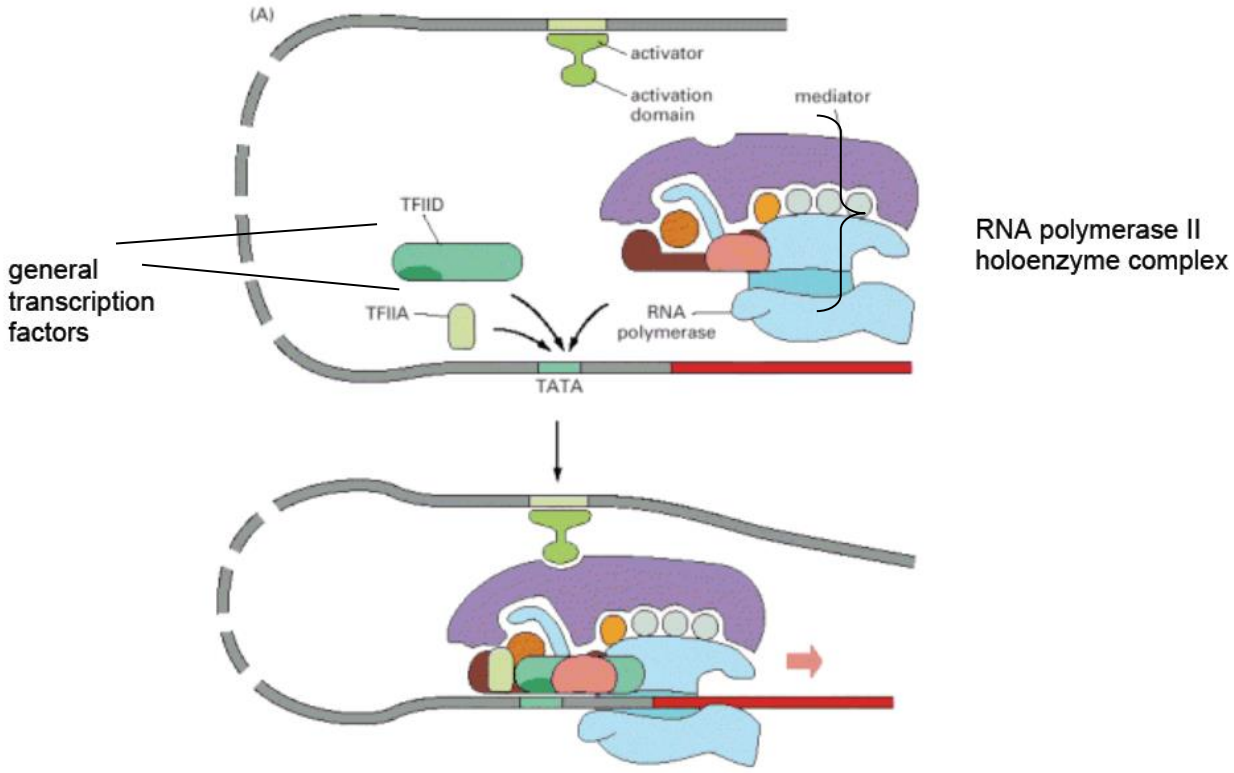


Fig.10.1

(a) With reference to Fig. 11.1, state two ways in which transcription in eukaryotes differs from that in prokaryotes. [2]

(b) With reference to Fig. 11.1, explain the mechanism behind the enhancement of the rate of transcription. [3]

Question 9 [12 marks]

HCI Prelims 08

In an experiment, chromatin from various chick tissues were isolated and treated with DNase I, an enzyme that degrades free double-stranded DNA in a non-specific manner. After digestion, the DNase I enzyme was removed. Any remaining intact DNA was extracted and mixed with radioactively labelled complementary DNA (cDNA) probe specific for certain gene.

Under conditions that favour probe-binding, the cDNA probe are able to detect presence of a complementary DNA sequence amongst a mixture of other DNA. Only DNA with base sequence complementary to the probe base sequence will bind to the probe via complementary base pairing.

The levels of binding of the labelled cDNA probes were measured. Some of the results are shown in Table 9.1 below.

Table 9.1

Sample	Tissue source of chromatin	DNase I treatment	Radioactive cDNA probe	% binding of radioactive cDNA to remaining DNA after DNase I digestion
1	Developing red blood cells (nucleated)	-	Globin cDNA	94
2	Developing red blood cells (nucleated)	+	Globin cDNA	25
3	Oviduct	+	Globin cDNA	91
4	Developing red blood cells (nucleated)	+	Ovalbumin cDNA	93
5	Oviduct	+	Ovalbumin cDNA	18

Globin: protein subunit of haemoglobin
Ovalbumin: main protein present in egg white
In animals that lay eggs, the formation of the shelled egg occurs in the oviduct, the passage from the ovaries to the outside of the body.

If the cDNA probe finds sequences to bind to, then the gene concerned is said to be 'protected' from DNase I digestion by chromatin proteins.

(c) (i) Name one such chromatin protein. [1]

(ii) Explain how these proteins protect the gene concerned from DNase I digestion. [2]

(d) With reference to Table 9.1,

(i) describe the difference in the levels of binding of the two types of cDNA probe for the developing RBC samples. [1]

(ii) state which gene is more actively transcribed in developing red blood cells. [1]

(iii) explain your answer to **(b)(ii)**. [2]

Fig 9.1 below represents the processing of pre-messenger RNA. PJC Prelims 2008

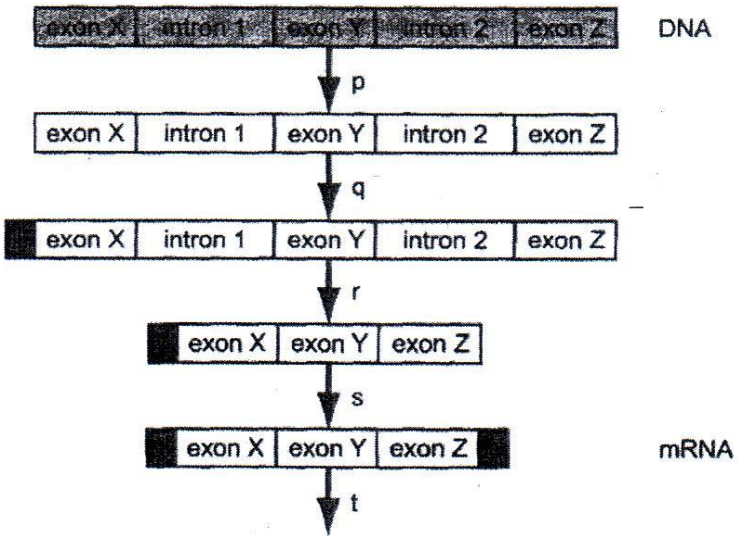


Fig 9.1

(e) Describe events r to t. [5]

Topic: CELL SIGNALLING

Question 10 RVHS 2014 Prelims P2 Q6

In recent years, significant advances have been made in defining the regulatory pathways that control normal and abnormal cardiac valve development. One of such includes the receptor tyrosine kinase activation and downstream signaling pathway shown in Fig. 6.1. The epidermal growth factor (EGF) activates the MAPK/ERK pathway to induce the transcription of targeted gene.

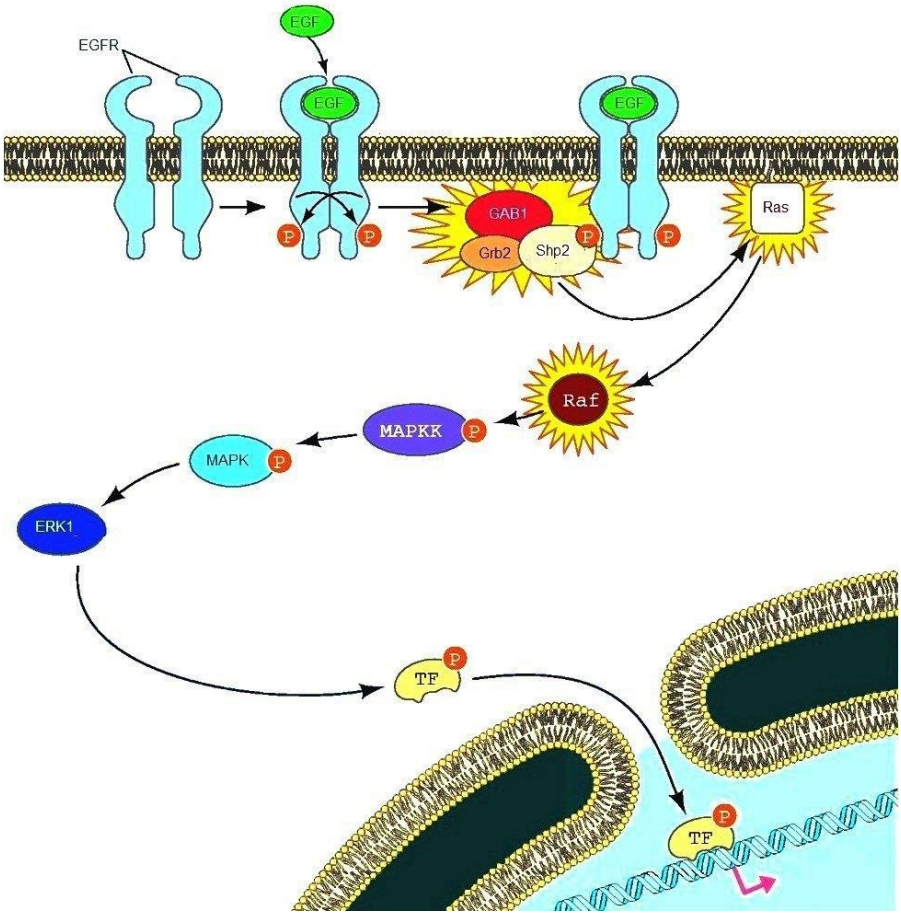


Image adapted from http://physiologyonline.physiology.org/content/20/6/390/F1

Fig. 6.1

(a) With reference to Fig. 6.1,

(i) describe how EGFR is activated, [3]

(ii) describe how the signal from the activated receptor is transduced to Raf. [3]

Oral glucose tolerance test is often employed to diagnose diabetes when simple blood and urine tests give inconclusive results. Following a 12 hour fast, a blood sample is then taken to measure the patient's fasting blood glucose level. He is then given a drink containing 75g of glucose, and his blood glucose concentration tracked for the next 2 hours.

Fig. 6.2 shows the blood glucose concentration of two individuals, one healthy and one with diabetes.

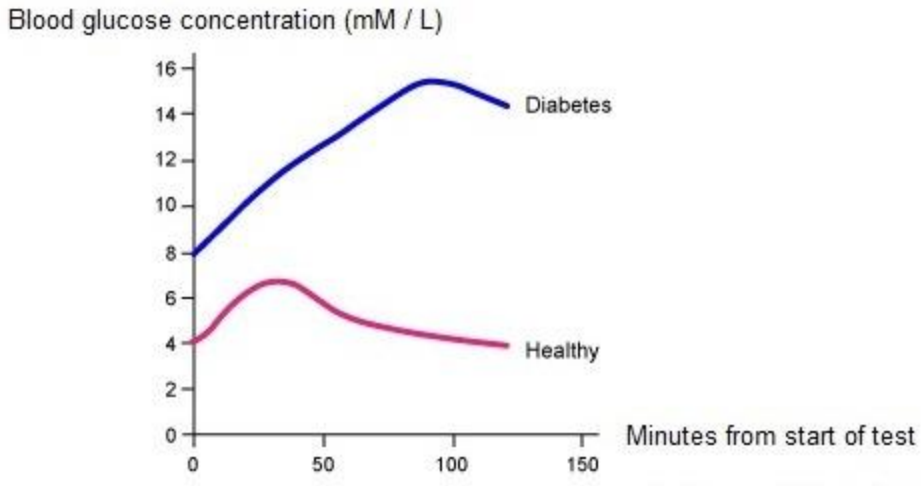


Image adapted from ABPI schools

Fig. 6.2

(b) Describe and explain the results of the test for the diabetic patient in the first 100 minutes. [3]

(c) Suggest a reason for the drop in blood glucose concentration for the diabetic patient. [1]

Question 11 CJC 2015 Prelims P2 Q2

Phosphate ions have a number of uses in organisms. These include:

- involvement in cell signalling responses
- involvement in energy transfer processes
- component of phospholipids
- component of nucleotides

Phosphatase enzymes remove phosphate groups from organic compounds, while kinase enzymes add phosphate groups.

(a) Read the following passage:

> Some hormones circulating in the blood are able to trigger transcription within a cell, even though they are unable to enter the cell. Phosphatases and kinases then take part in cell activities that eventually result in genes switching on and transcription beginning.

(i) Suggest why the hormones, referred to in the passage, are unable to enter the cell. [2]

(ii) Use the information in the passage to outline the process of cell signalling. [3]

Topic: STEM CELL

Question 12 [6 marks]

(a) Osteogenesis imperfecta (brittle bone disorder), is a genetic disorder characterised by bones that break easily.

Adult bone stem cells transplanted into children with osteogenesis imperfecta have stimulated growth of bone in these children. During the 6 months immediately following the transplant, the children's growth reached 60% to 94% of expected normal values for children their age.

(i) In terms of differentiation potential, explain how an adult bone stem cell is different from a fertilized egg of a human. [2]

(ii) Explain how the adult bone stem cells may increase bone growth in children with osteogenesis imperfecta. [2]

(b) Plant physiologists attempted to produce papaya plants using tissue culture.

They investigated the effects of different concentrations of two plant growth factors on small pieces of the stem tip from a papaya plant. Their results are shown in **Table 3**.

Table 3

Concentration of auxin / µmol dm^{-3}	Concentration of cytokinin / µmol dm^{-3}		
	5	25	50
0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

(i) With reference to Table 3, give evidence that the cells from the stem tips are totipotent. [2]

Topic: CANCER

Question 13 [8 marks] YJC Prelims 2009

Colorectal cancer includes cancerous growths in the colon, rectum and appendix. It is the third most common form of cancer and the second leading cause of cancer-related death in the Western world. Mutations in specific DNA sequences in the *ras* gene and *p53* gene, lead to uncontrolled cell division.

Researchers have isolated the *ras* and p53 protein and have used it to analyze the effects of these proteins on the development of colorectal cancer. The *ras* and p53 proteins were isolated from normal and cancerous tissues of a colorectal cancer patient.

Fig. 18.1 shows the band patterns obtained after protein electrophoresis. A darkly stained band indicates that there is high amount of the respective substance in that particular tissue type.

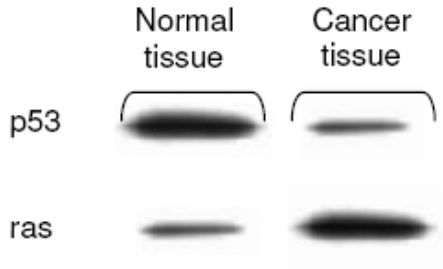


Fig. 18.1

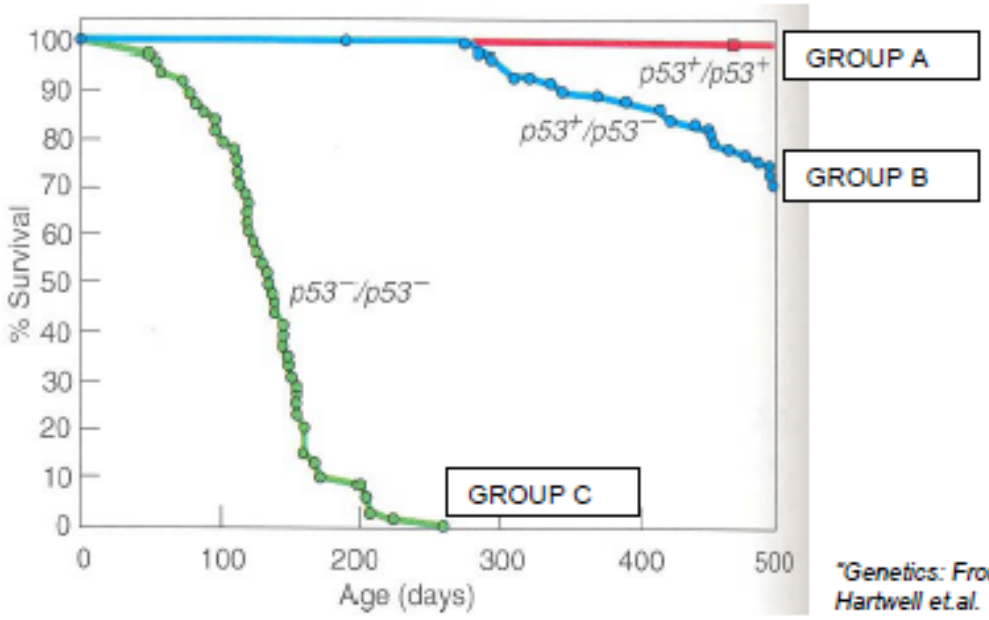
(a) With reference to Fig. 18.1, state how the levels of *ras* and p53 proteins correlate with the development of cancer. [2]

(b) State the role of the *ras* gene in relation to the development of cancer. [2]

(c) Explain how mutations in the *p53* gene may lead to uncontrolled cell division. [4]

Question 14 [13 marks] HCI Prelims 2008

The graph below shows the percentage survival of mice with different genotypes at the p53 gene locus. p53+ is the wild-type allele, and p53- is the mutant allele.



"Genetics: From Genes to Genomes" Hartwell et.al.

(a) Account for the difference between Group B and Group C mice. [3]

(b) Contrast the possible genetic changes that may lead to tumour formation in the p53 gene and in a proto-oncogene. [3]

(c) (i) Describe the significant changes in a mouse cell from the point of acquiring of the mutant p53 alleles to the cell becoming cancerous. [4]

(ii) Explain how can one cancerous cell eventually lead to the death of the mouse. [3]

Topic: GENETICS OF VIRUSES

Question 15 [14 marks] NJC Prelim 2013 and RVHS Prelim 2013

Human Immunodeficiency Virus (HIV) is the culprit of Acquired Immunodeiciency Syndrome (AIDS) which, till now, has no full cure.

Figure 3.1 shows the reproductive cycle of HIV.

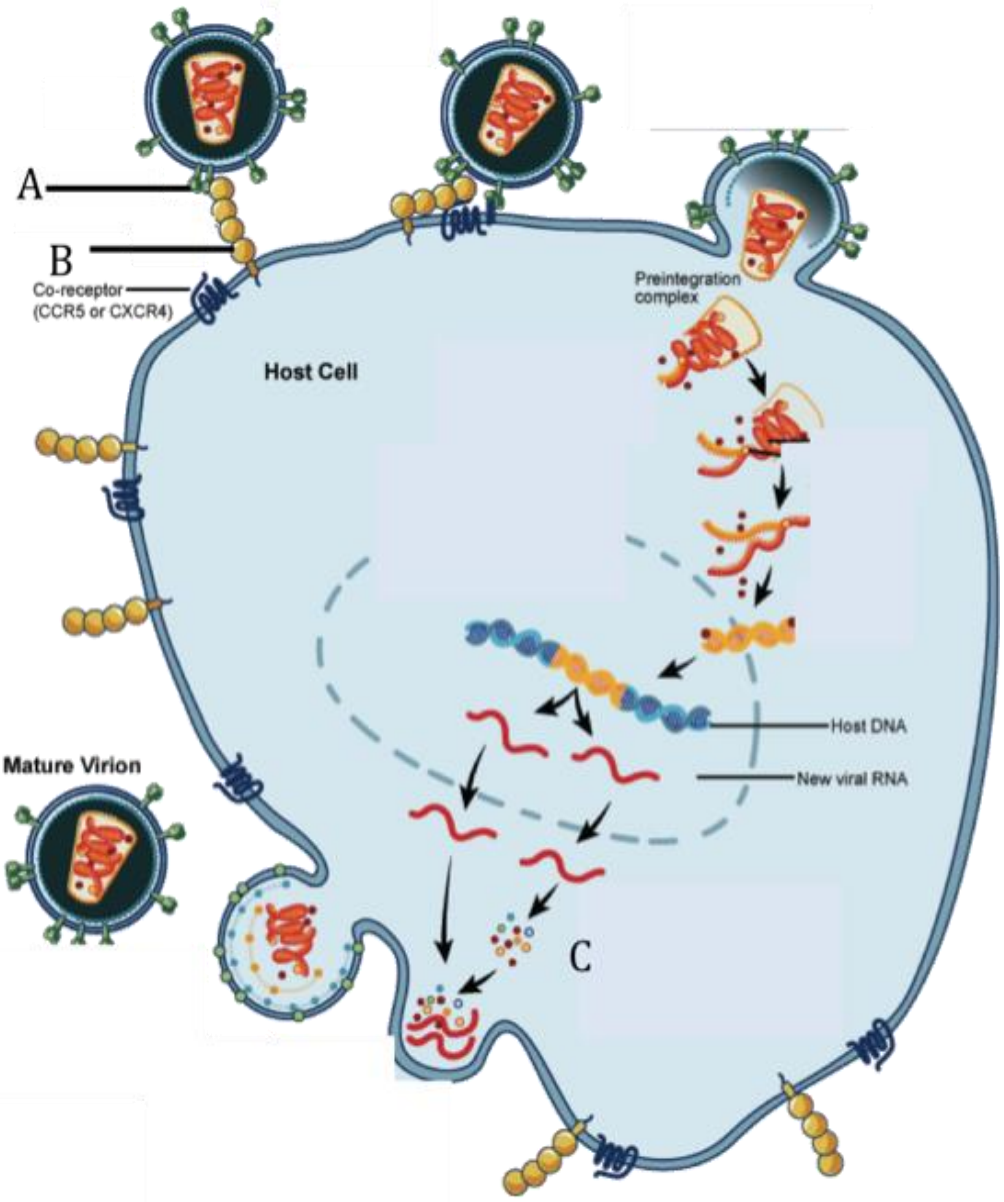


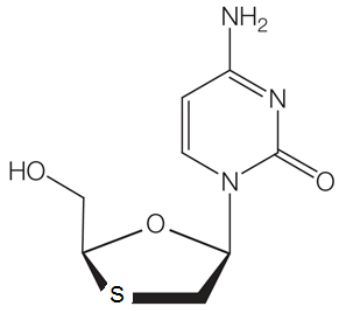
Fig.3.1

(a) Name structures A and B. [2]

(b) Describe the events occurring in stage C leading to formation of structure A on the host cell's plasma membrane. [3]

(c) After contraction of HIV, the initial symptoms are followed by a stage called clinical latency when no symptoms are observed for a few years. With reference to the reproductive features of HIV, explain the cause of clinical latency. [2]

Lamivudine is an antiviral medication that prevents Human Immunodeficiency Virus (HIV) from multiplying in the body. The structure of lamivudine, an analogue of viral nucleotide, is shown in Fig. 3.2.



Lamivudine

Fig. 3.2

(d) Explain how lamivudine prevents HIV from multiplying in the body. [2]

Many drugs have been designed to make it possible for AIDS patients to improve their overall health and extend their lives. However, most of these drugs have low efficacy due to high variance in the HIV genome. Fig. 3.3 shows the partial cDNA sequence of glycoprotein 120 (gp120) on two different strains of HIV found in a host cell. The difference in the two DNA sequences is indicated via a box.

HIV Strain 1

61 ctgaaaatct cgaaaacaat gccaaaacca taatagtgca ccttaataaa tctgtagaaa
121 tcaattgtac cagaccctcc aacaatacaa gaacaagtat aactatagga ccaggacaag
181 tatggtatag aacaggagac ataataggaa atataagaaa agcatattgt gagattaatg
241 gaacaaaatg gaataaagtt ttaaaacagg taactgaaaa attgaaagag cactttaata
301 ataagacaat aatctttcaa ccac

HIV Strain 2

61 ctgaaaatct cgaaaacaat gccaaaacca taatagtgca ccttaataaa tctgtagaaa
121 tcaattgtac cagaccctcc aacactacaa gaacaagtat aactatagga ccaggacaag
181 tatggtatag aacaggagac ataataggaa atataagaaa agcatattgt gagattaatg
241 gaacaaaatg gaataaagtt ttaaaacagg taactgaaaa attgaaagag cactttaata
301 ataagacaat aatctttcaa ccac

Fig. 3.3

(e) Explain how the genomic variation shown in Fig. 3.3 affects the structure of gp120 on the two strains of HIV. [3]

(f) Flu is caused by influenza viruses. Distinguish the genome replication between HIV and influenza virus. [2]