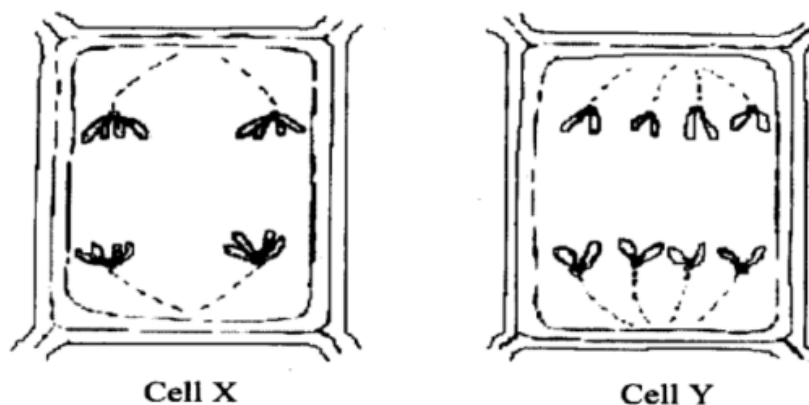


## Pra-PSPM Biology KML (2023/2024)

1. **FIGURE 1** shows two cells **X** and **Y**, in a flowering plant. The parent cell has 4 chromosomes. Each cell shows the chromosomal behaviour during the process of cell division.



**FIGURE 1**

- a) Identify the stage that takes place in **Cell X** and **Cell Y** during the cell division. [2 marks]

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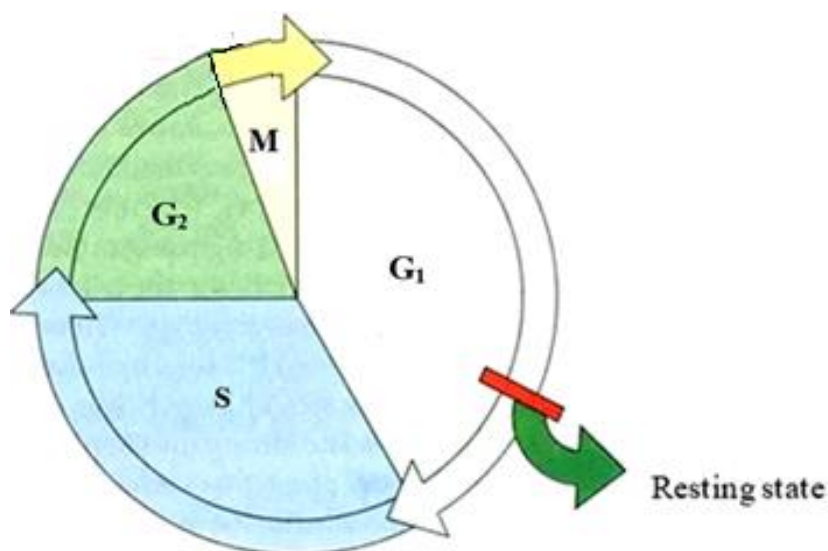
- b) State the chromosomal behaviour for **Cell X** and **Cell Y**. [2 marks]

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- c) **FIGURE 2** shows the phases in cell cycle.



**FIGURE 2**

- (i) If the amount of DNA in  $G_1$  phase is 18, predict the amount of DNA in  $G_2$  phase. Explain your answer. [2 marks]

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- (ii) Give ONE factor that may cause a cell at G<sub>1</sub> entering the resting state. [1 mark]

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2. a) A pod shape trait is observed in a cross of two true-breeding pea plant varieties, the dominant and the recessive varieties. In this cross, the trait is seen to be either smooth (P) or constricted (p).

- (i) If this cross obeys Mendelian inheritance, determine the possible genotypic ratio if the F<sub>1</sub> generation are self – crossed. [1 mark]

- (ii) In a following experiment using the same true – breeding pea plants (dominant and recessive) varieties, the pod shape is also observed with an additional trait i.e. seed colour. The second trait is seen to be either yellow (G) or green (g). If this cross also obeys Mendelian inheritance, construct a genetic diagram to show the possible outcome if the F<sub>1</sub> generation are self – crossed. Use Punnet square to show the process. [4 marks]

- (iii) In a separate experiment observing the two traits of the same pea plant varieties, the F<sub>1</sub> generation is seen to exhibit smooth pod shape and yellow seed colour. However, when the F<sub>1</sub> generation is crossed with a true breeding recessive of the same pea plant varieties, the F<sub>2</sub> progenies produced do not seem to exhibit a relatively similar proportion among each other. Construct a genetic diagram to depict to the possible explanation to this finding. [3 marks]

- b) Muscular dystrophy is a sex-linked disorder that involves muscle weakness and loss of muscle tissues that get worse over time. Muscular dystrophy is expressed in the recessive allele with the dominant allele being “normal” or without muscular dystrophy.
- (i) A normal man who has a brother with M.D. marries a homozygous normal woman. What is the probability that any of their children will have M.D.? Show your explanation by using a Punnet square. [3 marks]

- (ii) A female carrier has children with a male who has M.D. What is the percentage that they will have a child who is both male and has M.D? [2 marks]

3. Approximately 4% of a tortoise population in a pond shows the recessive phenotype long nose.

- c) Calculate frequencies of dominant and recessive alleles in the population. [2 marks]

- d) If the original number of the tortoises in the population is 5000, and then 120 of the tortoises with long nose were suddenly removed, calculate the new allele frequencies. [4 marks]

4. a) If the gene for DNA polymerase I was mutated, how would that affect DNA replication? [2 marks]

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b) Explain why half of the DNA is replicated in a discontinuous way? [2 marks]

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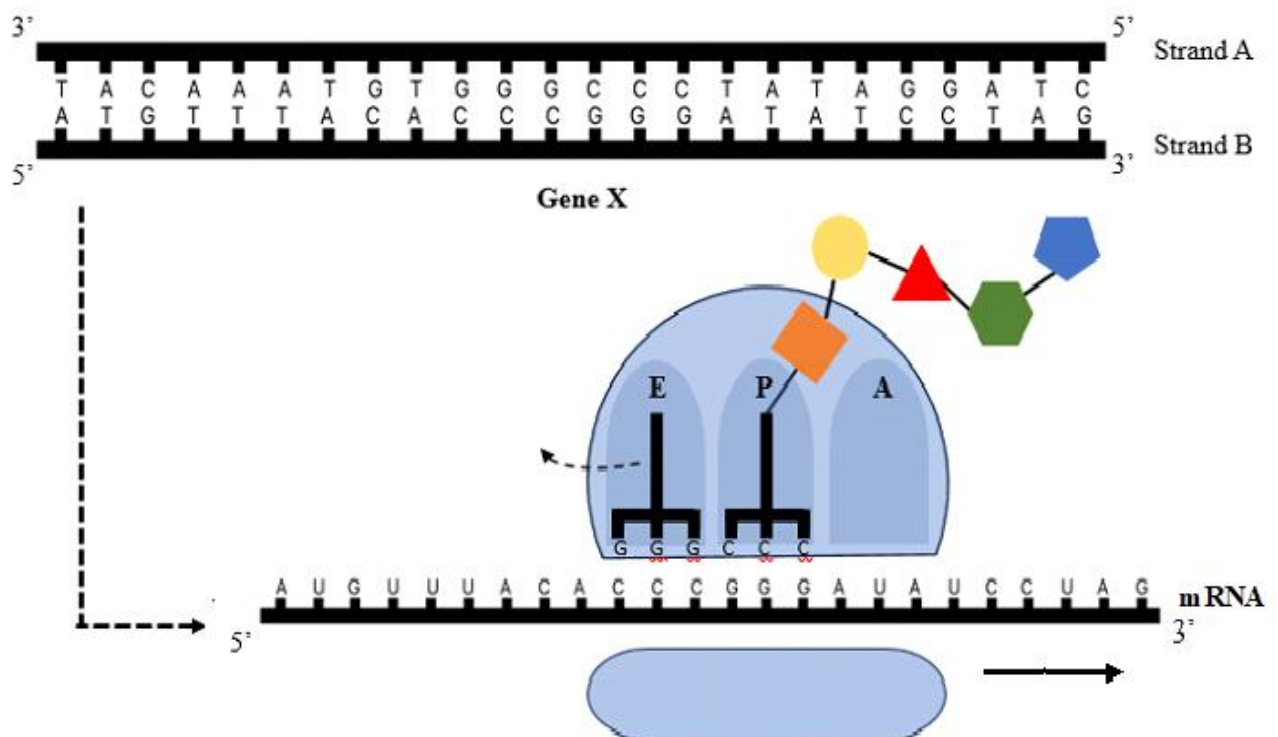
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c) Given that the sequence of the template strand is 5' ATTCCGTAGC 3'. What is the sequence of the new strand formed? [1 mark]

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d) **FIGURE 3** shows the processes involved in the synthesis of a protein coded by **Gene X**.



**FIGURE 3**

(i) Which of the two DNA strands of **Gene X** will be used as a template during transcription? [1 mark]

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(ii) Explain what happens following the binding of RNA polymerase on Gene X. [1 mark]

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(iii) On the mRNA in **FIGURE 3**, circle the codon where the translation process is initiated. [1 mark]

- (iv) Name the stage of translation shown in **FIGURE 3**. State the reason for your answer. [2 marks]

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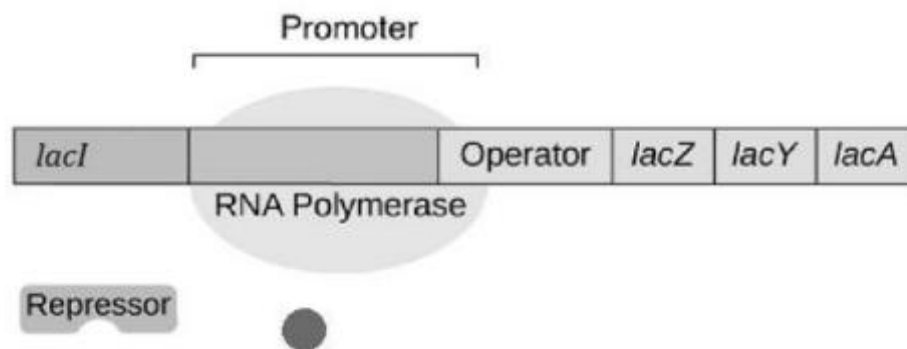
- (v) Based on **FIGURE 3**, explain the discontinuation of addition of more amino acids by the ribosome to the polypeptide chain at the end of translation. [1 mark]

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- e) **FIGURE 4** shows the *lac* operon model.



**FIGURE 4**

- (i) Briefly explain the mechanism of the *lac* operon involved if *E. coli* cultured in a medium that contains no glucose but has lactose. [2 marks]

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- (ii) How would the mutation in *lacZ* gene affect the *lac* operon? [1 mark]

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5. **FIGURE 5** shows the mRNA codon sequence of a normal and an abnormal haemoglobin.

Normal haemoglobin	5'	ACU	CCU	GAG	GAA	3'
Abnormal haemoglobin	5'	ACU	CCU	GUG	GAA	3'

**FIGURE 5**

- a) The mutation in **FIGURE 5** causes a genetic disease that produces sickle-shaped red blood cells. Explain how this happens. [2 marks]

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- b) The table below shows the amino acid sequence of a polypeptide chain from four different, but related species. Assuming that species I is the ancestral species of the group.

Species	Amino acid sequence
I	Val – His – Leu – Val – Glu – Glu – His – Val – Glu – His ---
II	Val – His – Leu – Val – Glu – Glu – His – Val – Glu – His ---
III	Val – His – Leu – Val – Glu – Glu – His – Val
IV	Val – His – Leu – Val – Arg – Trp – Ala – Cys – Met – Asp ---

- (i) According to the table above, identify the most likely genetic change that produced the polypeptide in species IV. Explain your answer. [2 marks]

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- (ii) Based on the table above, what type of mutation has occurred in species III. Give your reason. [3 marks]

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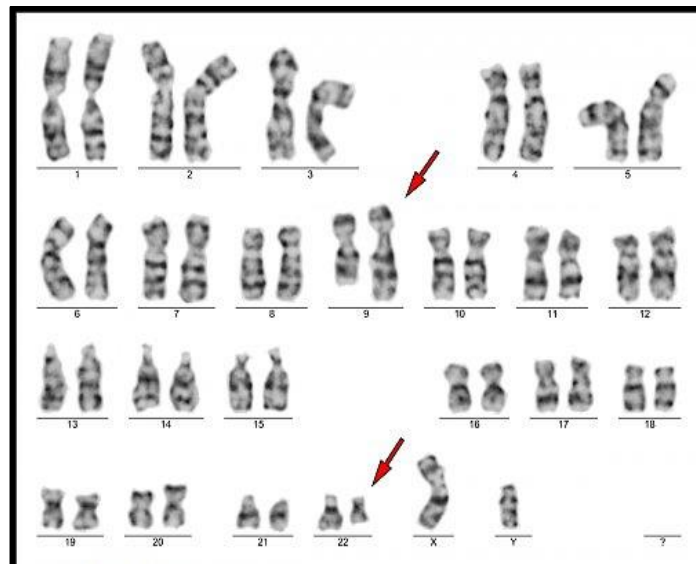


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- c) **FIGURE 6** shows the karyotype of a patient with a mutation that involves chromosomes 9 and 22 indicated by the arrows.



**FIGURE 6**

- (i) Name the genetic disorder caused by the mutation shown in **FIGURE 6** and state the type of mutation involved. [2 marks]

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- (ii) Differentiate between the genetic disorder in (i) and Monosomy 21. [2 marks]

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6. a) **FIGURE 7** below shows a segment of DNA involved in gene cloning.



**FIGURE 7**

- (i) Based on **FIGURE 7**, explain how restriction endonuclease, *EcoRI* function. [2 marks]

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- (ii) Under relaxed conditions, there are normally 10 to 700 copies of plasmids present in the host cell. State the characteristic of plasmid related to this condition. [1 mark]

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- (iii) Recombinant DNA is transformed into the host cell, *E. coli* in gene cloning. State **one** feature of the host cell that allows this step to occur. [1 mark]

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- b) Explain the production of cDNA. [5 marks]

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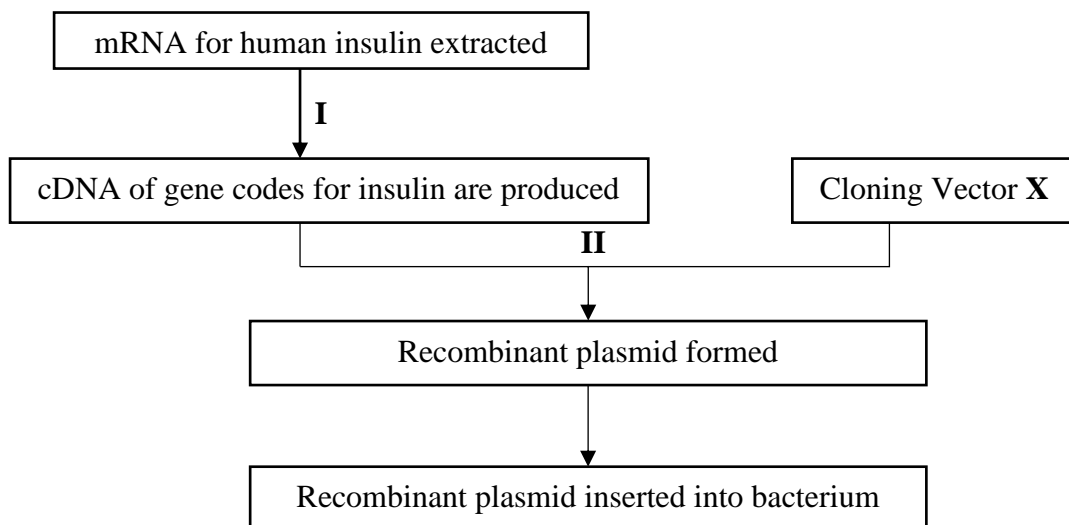
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- (c) **FIGURE 8** shows the stages in the production of genetically modified bacteria in synthesising human insulin.



**FIGURE 8**

- (i) Based on **FIGURE 8**, explain the function of the enzyme used in step **I**. [1 mark]
- \_\_\_\_\_
- \_\_\_\_\_
- (ii) Why is it more advantageous to use mRNA instead of nuclear DNA to synthesize insulin? [1 mark]
- \_\_\_\_\_
- (iii) What will happen if the enzyme involved in **step II** is non-functional? [1 mark]
- \_\_\_\_\_
- (iv) In what way has the production of human insulin by recombinant DNA technology given significant medical advantages for diabetic patients compared to insulin that is taken from animal sources? [1 mark]
- \_\_\_\_\_
7. a) Name and explain the phase in ovarian cycle that leads to negative feedback mechanism and state its importance. [6 marks]
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b) Explain the events involved in acrosomal reaction. [2 marks]

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c) Jenny is 41 weeks pregnant but she only experienced a few mild contractions (each lasting about 15–20 seconds); Her cervix is only 2 cm dilated, and the amniotic sac is intact. Jenny is therefore admitted to the birthing unit and given an IV infusion of Pitocin, a synthetic hormone which will increase the frequency and strength of her uterine contractions.

(i) Name TWO hormones that have similar functions as Pitocin. [1 mark]

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(ii) How does the level of the two hormones mentioned in c(i) cause a longer labour duration? [1 mark]

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(iii) What is the hormone that is detectable in the blood and urine of a pregnant individual? [1 mark]

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(iv) Premature birth or preterm birth occurs when a baby is born before completing 37 weeks of pregnancy. In a healthy pregnancy, premature birth can be avoided by the involvement of two hormones. Name the TWO hormones and explain their respective roles in a healthy pregnancy. [3 marks]

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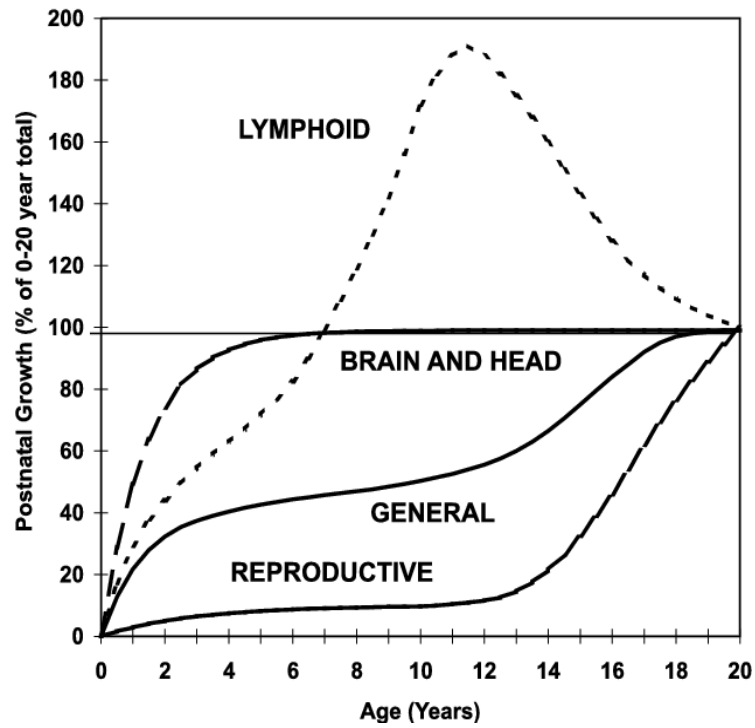
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d) **FIGURE 9** shows a growth pattern in humans.



**FIGURE 9**

(i) Determine the growth pattern shown in **FIGURE 9**. [1 mark]

(ii) Based on **FIGURE 9**, differentiate between the growth rate of head and lymphoid organ. [1 mark]