

1. **FIGURE 1** shows chromosomal behaviour during two stages of cell division in an organism.

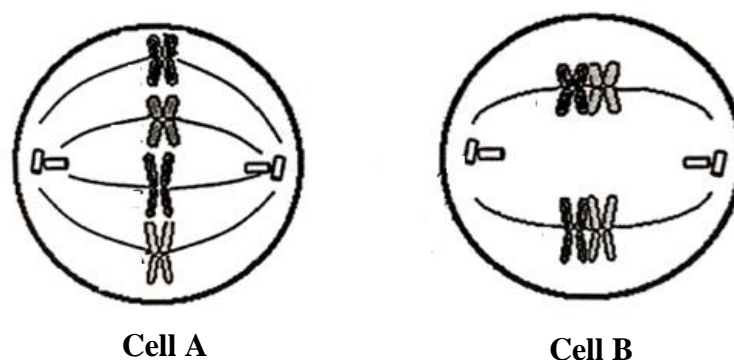


FIGURE 1

(a) Identify the types of cell division for Cell A and Cell B.

[2 marks]

Answer	Marks
A : mitosis	1
B : meiosis/meiosis I	1

(b) Give **ONE** difference between stages shown in Cell A and Cell B.

[1 mark]

Answer	Marks
In Cell A, sister chromatids/chromosomes align at metaphase plate while in Cell B, homologous chromosomes align at metaphase plate	1

(c) How many chromosomes in each daughter cell of cell A and cell B after its complete cell division?

[2 marks]

Answer	Marks
Cell A : 4	1
Cell B : 2	1

(d) Explain what happens if cell A fail to divide its cytoplasm?

[2 marks]

Answer	Marks
Cell A will have more than one nucleus with connected cytoplasm	1
Tetraploid/4n cell is produced	1

2. (a) The phenotypes of watermelon are controlled by two genes, **R** (fruit shape) and **L** (skin type). Round fruit is dominant to long fruit and smooth skin is dominant to wrinkled skin. The genes are located on the different chromosome.

- (i) Identify the genotype of heterozygous round fruit with homozygous smooth skin watermelon.

[1 mark]

Answer	Marks
RrLL	1

- (ii) Genotype of watermelon answered in (a)(i) were crossed with homozygous recessive watermelon.

Use a punnett square to show the cross and the ratio of offspring phenotypes.

[4 marks]

Answer			Marks						
P/ Parental genotype	:	RrLL X rrll	1						
G/ Gamete	:	<div><div>RL</div><div>rL</div><div>rl</div></div>	1						
F ₁ genotype (Punnett square)	:	<table><tr><td></td><td>RL</td><td>rL</td></tr><tr><td>rl</td><td>RrLl</td><td>rrLl</td></tr></table>		RL	rL	rl	RrLl	rrLl	1
	RL	rL							
rl	RrLl	rrLl							
F ₁ Phenotypic ratio	:	1 round, smooth : 1 round wrinkled	1						

- (b) Haemophilia is an X-linked recessive disorder that prevents blood clotting.

- (i) Define X-linked recessive inheritance.

[1 marks]

Answer	Marks
Genes located on X chromosome// Mutated gene/recessive allele on X chromosomes	1

- (ii) Peter, a haemophiliac male, marries Diana, whose normal but carry recessive allele on her X chromosome. Using suitable symbols, draw a genetic diagram and a Punnett square to show the possible genotypes and phenotypes of offspring including the ratio of their phenotypes.

[6 marks]

Answer	Marks									
<div><div><div>Diana</div><div>Parental genotype /P : $X^H X^h$</div></div><div><div>Peter</div><div>$X^h Y$</div></div><div>X</div></div>	1+1									
<div><div>Punnett square</div><table><tr><td></td><td>X^H</td><td>X^h</td></tr><tr><td>X^h</td><td>$X^H X^h$</td><td>$X^h X^h$</td></tr><tr><td>Y</td><td>$X^H Y$</td><td>$X^h Y$</td></tr></table></div>		X^H	X^h	X^h	$X^H X^h$	$X^h X^h$	Y	$X^H Y$	$X^h Y$	
	X^H	X^h								
X^h	$X^H X^h$	$X^h X^h$								
Y	$X^H Y$	$X^h Y$								
Correct 4 gametes written in Punnett square	1									
Correct offspring genotype/ gamete combination	1									
<div><div>Correct offspring phenotypes</div><div><div>$X^H X^h$: carrier female</div><div>$X^h X^h$: haemophiliac female</div><div>$X^H Y$: normal male</div><div>$X^h Y$: haemophiliac male</div></div></div>	1									
<div><div>Ratio of phenotype offspring</div><div>2 haemophilic : 2 normal //</div><div>2 haemophilic : 1 normal : 1 carrier</div></div>	1									
Total	6									

3. In a population of hamster, allele for grey fur (**G**) is dominant over allele for black fur (**g**). It was found that 36% of the hamster have black fur. It is assumed that the population is at genetic equilibrium.

- (a) Calculate the frequency of grey and black fur alleles.

[4 marks]

Answer	Marks
Frequency of black hamster /homozygous recessive genotype, $q^2 = 0.36$	1
Frequency of black allele/recessive allele, $q = \sqrt{0.36} = 0.6$	1
$p + q = 1$	1
Frequency of grey allele/dominant allele, $p = 1 - 0.6 = 0.4$	1

- (b) Calculate the number of grey fur hamster in a population of 800 hamster.

[2 marks]

Answer	Marks
<p>Frequency of grey fur hamster , $p^2 + 2pq = (0.4)^2 + 2(0.4)(0.6)$ $= \underline{0.64}$</p> <p>@</p> <p>$1 - q^2 = 1 - 0.36 = \underline{0.64}$</p> <p>Number of grey fur hamster = $0.64 \times 800 = \underline{512}$</p>	1
Number of grey fur hamster = $0.64 \times 800 = \underline{512}$	1

4. (a) **FIGURE 2** shows protein synthesis that occurs in eukaryotic cell.

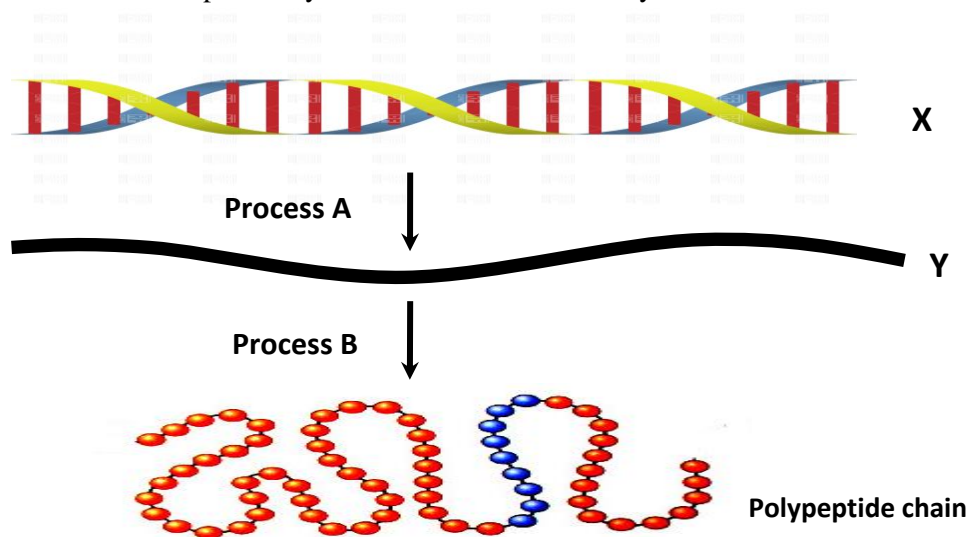


FIGURE 2

- (i) Name strand Y.

[1 mark]

Answer	Marks
mRNA / messenger RNA	1

- (ii) What is the function of strand Y in process B?

[1 mark]

Answer	Marks
Act as a template/carry genetic material for synthesis of protein	1

(iii) Explain **THREE** differences between processes **A** and **B**.

[3 marks]

Answer	Marks
Process A uses a DNA strand as a template while process B uses an mRNA strand as a template	1
Process A produces an mRNA strand while process B produces a polypeptide chain/protein	1
Process A involve RNA polymerase while process B involve aminoacyl-tRNA synthetase <u>and</u> peptidyl transferase	1
	Max 3

(b) Explain a gene expression regulation by the lac operon in the presence of lactose in *E.coli*.

[9 marks]

Answer	Marks
i. Regulatory genes/ <u>lacI</u> codes for repressor protein	1
ii. Lactose is converted into allolactose	1
iii. Allolactose binds to <u>lac</u> repressor protein	1
iv. Causes <u>lac</u> repressor protein change its conformation/shape	1
v. <u>lac</u> repressor protein unable to bind to <u>lac</u> operator/detached from <u>lac</u> operator	1
vi. Allow RNA polymerase to bind to <u>lac</u> promoter	1
vii. Transcription of structural genes/ <u>lacZ</u> , <u>lacY</u> and <u>lacA</u> can occur	1
viii. Enzymes β -galactosidase, permease <u>and</u> transacetylase can be synthesised	1
ix. Lactose is broken down into glucose and galactose	1
	Max 9

5. (a) **FIGURE 3** shows the types of chromosomal aberration.

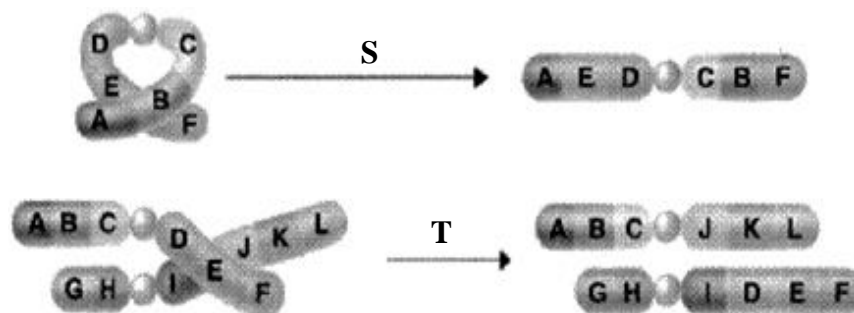


FIGURE 3

(i) Identify chromosomal aberration **S** and **T**.

[2 marks]

Answer	Marks
S : Inversion	1
T : (reciprocal) translocation	1

(ii) State **ONE** difference between chromosomal aberration **S** and **T**.

[1 mark]

Answer		Marks
S	T	
A segment of a chromosome breaks off and reattaches in reverse order	Involves a region of a chromosome breaking off and rejoining to a non-homologous chromosome	1
Involve 1 chromosome	Involve 2 chromosomes	1
		Any 1

(b) **FIGURE 4** shows the karyotype of two individuals suffering from genetic disorders.

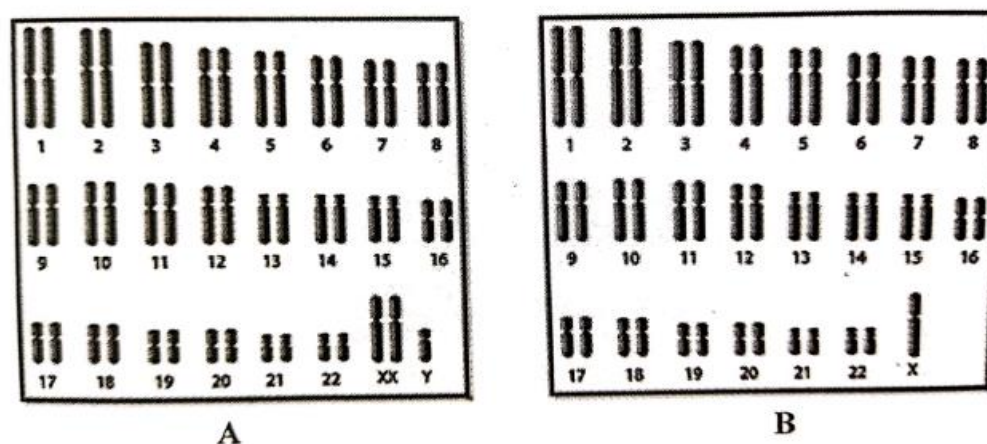


FIGURE 4

(i) State the ploidy level of individual **A** and **B**.

[2 marks]

Answer	Marks
A : $2n + 1$	1
B : $2n - 1$	1

(ii) Give **TWO** characteristics of individual **B**.

[2 marks]

Answer	Marks
Sterile female	1
Webbed neck	1
Short stature	1
Lack of menstruation	1
Underdeveloped secondary female sexual characteristics/breast/ovary	1
Triangular face	1
	Any 2

(iii) How does the genetic disorder in individual **A** occur?

[4 marks]

Answer	Marks
i. Nondisjunction of sex chromosomes XX // XX chromosomes fail to separate	1
ii. during oogenesis // during meiosis I / anaphase I in <u>female</u>	1
iii. Produce abnormal ovum/egg/female gamete with genotype 22+XX	1
iv. The abnormal gamete fertilise with normal sperm/male gamete with Y chromosomes/22+Y	1
v. Produce abnormal zygote with genotype 44+XXY	1
	Any 4
OR	
i. Nondisjunction of sex chromosomes XY // sex chromosomes XY fail to separate	1
ii. during spermatogenesis// during meiosis I/ anaphase I in <u>male</u>	1
iii. Produce abnormal sperm/male gamete with genotype 22+XY	1
iv. The abnormal sperm/male gamete fertilise with normal ovum/egg/ female gamete, 22+X	1
v. Produce abnormal zygote with genotype 44+XXY	1
	Any 4

6. (a) **FIGURE 5** shows two DNA strands, **P** and **Q**.

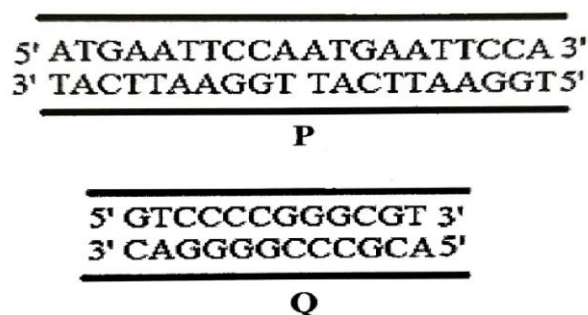


FIGURE 5

- (i) Identify the restriction enzymes which cut **P** and **Q**.

[2 marks]

Answer	Marks
P : <u>EcoRI</u>	1
Q : <u>SmaI</u>	1

- (i) What would happen if the restriction enzyme in bacterial cell fails to function?

[1 mark]

Answer	Marks
Unable to cut / cleave / degraded the viral /foreign DNA // cannot defend against virus // cannot prevent replication of viral DNA	1

- (b) **TABLE 1** shows the result of screening process in recombinant DNA technology by using antibiotics and X-gal.

Number of bacterial colonies			
Original	Ampicillin		Tetracyclin
	White	Blue	
50	10	30	0

TABLE 1

- (i) Identify the screening technique used.

[1 mark]

Answer	Marks
Blue-white screening screening	1

(ii) Why does the growth of bacterial colony is inhibited by tetracyclin antibiotics?

[1 mark]

Answer	Marks
Because plasmid/bacteria do not have gene resistant to antibiotic tetracyclin / tetracyclin resistance gene	1

(iii) What is indicated by the white colonies?

[1 mark]

Answer	Marks
Bacteria/host cells contain recombinant plasmid/DNA	1

(iv) Explain your answer in 6(b)(iii).

[3 marks]

Answer	Marks
Plasmid with non-functional/disrupted <u>lacZ</u> gene (since gene of interest is inserted within it)	1
β -galactosidase cannot be synthesized	1
X-gal cannot be hydrolyzed	1

(c) **FIGURE 6** shows part of the stages in the synthesis of human insulin using recombinant DNA

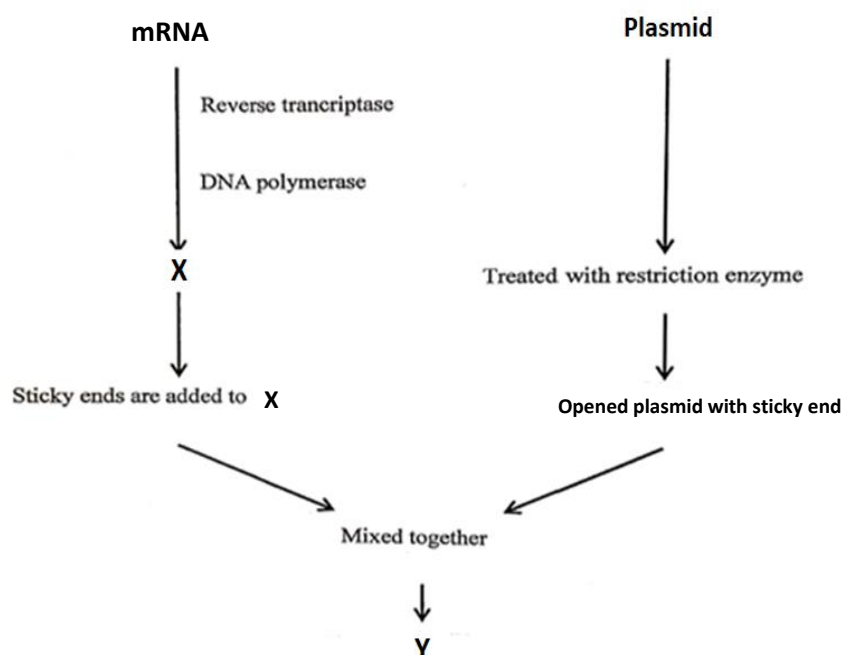


FIGURE 6

(i) Identify molecule **X** and **Y**.

[2 marks]

Answer	Marks
X : cDNA / complementary DNA	1
Y : recombinant DNA/recombinant plasmid	1

(ii) What would be the consequences if enzyme DNA polymerase is not functional?

[1 mark]

Answer	Marks
Second / Double strand of cDNA cannot be formed	1

(iii) Explain briefly how sticky ends are linked when **X** and opened plasmid molecule are mixed.

[2 marks]

Answer	Marks
Formation of hydrogen bonds between <u>complementary bases</u>	1
Phosphodiester bond formed between plasmid and X / cDNA	1

7. (a) Explain briefly the consequences if megaspore mother cells fails to undergo meiosis.

[3 marks]

Answer	Marks
Megaspore do not form	1
<u>1</u> egg cell, <u>2</u> synergid cells, <u>3</u> antipodal cells <u>and</u> <u>1</u> central cell/<u>2</u> polar nuclei are not formed	1
Double fertilisation does not occur	1

(b) **FIGURE 7** shows the concentration of hormones during pregnancy.

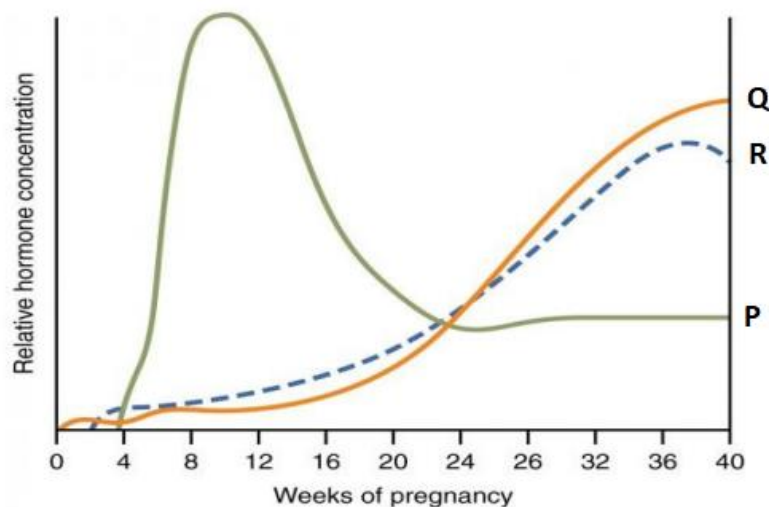


FIGURE 7

(i) Name hormone **P**, **Q** and **R**.

[3 marks]

Answer	Marks
P : hCG / human chorionic gonadotropin	1
Q : estrogen	1
R : progesterone	1

(ii) Describe the role of hormone **P** during the first trimester of pregnancy.

[2 marks]

Answer	Marks
To ensure corpus luteum maintained and continue	1
to secrete progesterone and estrogen	1

(iii) State why hormone **P** decline after the first trimester of pregnancy.

[2 marks]

Answer	Marks
Corpus luteum disintegrate / degenerate	1
Placenta is fully developed	1
Placenta continue to secrete estrogen <u>and</u> progesterone	1
	Any 2

- (iv) During second trimester of pregnancy, 20% of woman may experience bleeding. Relate bleeding with the level of hormone **R** during pregnancy.

[2 marks]

Answer	Marks
Low level of hormone R /progesterone	1
Causes shedding of endometrium wall	1

- (v) Explain the significance of the increasing levels of hormone **Q** during last weeks of pregnancy?

[2 marks]

Answer	Marks
Hormone Q /estrogen stimulates formation of oxytocin receptor on the uterine wall	1
And stimulate posterior pituitary gland to secrete oxytocin	1

- (c) **FIGURE 8** shows two types of plant growth pattern. Give TWO differences between **P** and **Q**.

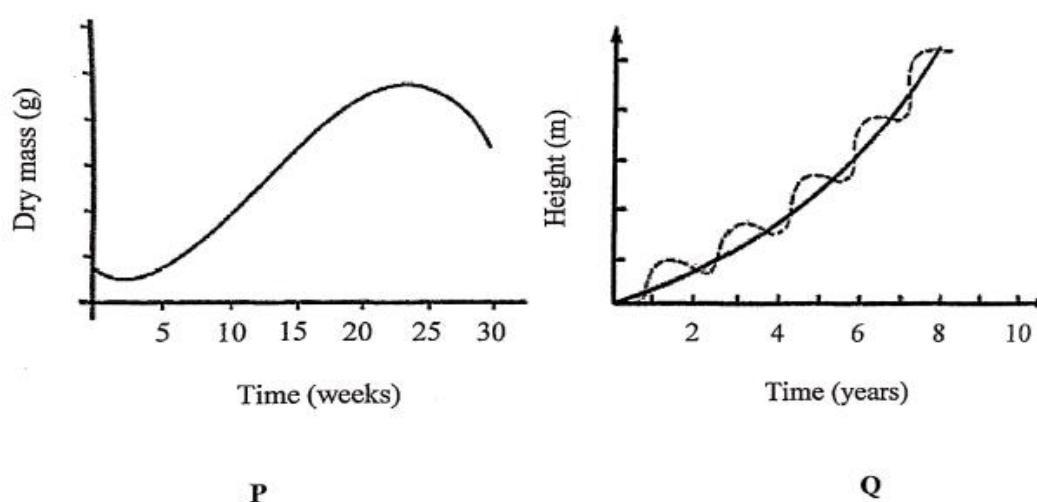


FIGURE 8

[2 marks]

Answer	Marks
P consists of one sigmoid curve while Q consists of series of sigmoid curves	1
P is limited growth while Q is unlimited growth	1
P could be found in annual plant while Q can be found in perennial plant	1
	Any 2