SB015
Biology 1
Semester 1
Session 2023/2024
2 hours

Name : _____

Class : _____

BIOLOGY UNIT

KOLEJ MATRIKULASI PERAK

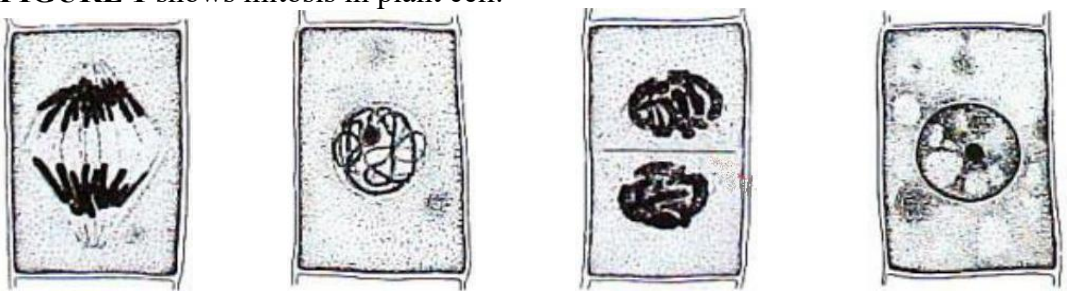
Road To Champion
Set 1

DO NOT OPEN THIS QUESTION BOOKLET UNTIL YOU ARE TOLD TO DO SO

Instructions:
1. This question booklet consists of 7 questions.
2. Answer all the questions in the space provided in the question paper

Questions No	Marks
1	/7
2	/13
3	/6
4	/14
5	/11
6	/13
7	/16
TOTAL	/80

1. (a) **FIGURE 1** shows mitosis in plant cell.



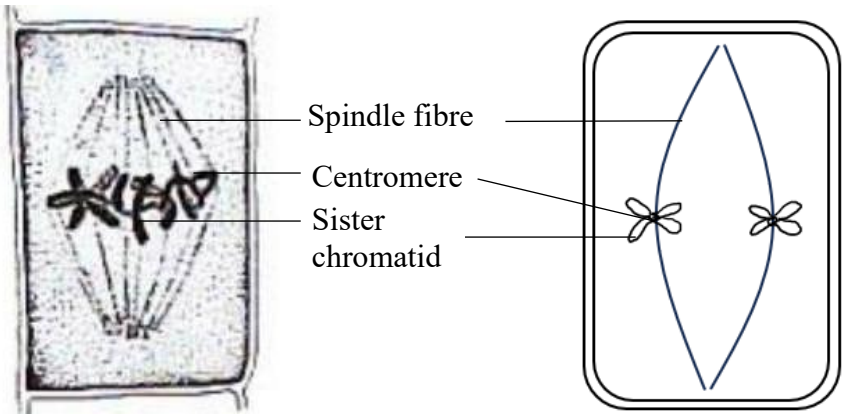
A B C D

FIGURE 1

i. Name the stage which is not shown in **FIGURE 1**. [1 *mark*]

Metaphase

ii. With the aids of labelled diagram, state the behaviour of chromosome in a(i). [3 *marks*]



Sister chromatid/~~chromosome~~ align at metaphase plate.

****Remark:**
Diagram : ~~***1 mark***~~
Label (any 2) : **1 *mark***
Chromosome behaviour : **1 *mark***
*** Presence of centriole, or round shape cell- No marks for Diagram*

***** number of chromosomes not necessary**

(b) How does cytokinesis in plant cell differ from animal cell. [1 *mark*]

(Cytokinesis in) Plant cell involves the formation of cell plate while (cytokinesis in) animal cell involves the formation of cleavage furrow.

(c) Spindle fibres are important during cell division. What happen if spindle fibres are fail to form? [2 *marks*]

- **Sister chromatids fail to separate and move to opposite pole// non-disjunction of sister chromatids occur// Sister chromatids cannot align at metaphase plate**
- **Produce daughter cell with extra (copies of) chromosome**

2. (a) A researcher carried out a cross on pea plants to determine the inheritance of seed forms. He crossed pure line wrinkled seed with pure line smooth seed to produce F_1 generation and subsequently F_2 generation. A total of 260 plants were produced in F_2 generation, 63 with wrinkled seeds and 197 with smooth seeds. **FIGURE 2** below illustrates the crosses.

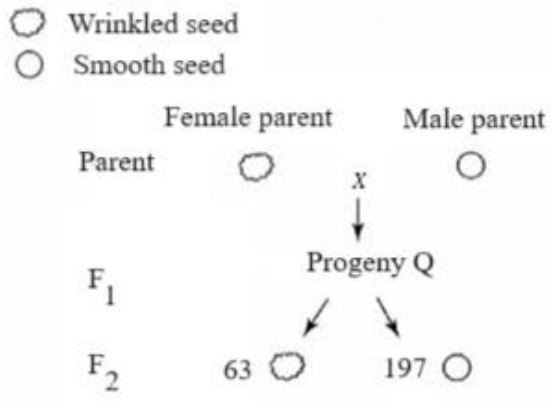


FIGURE 2

(i) What is the phenotype of progeny Q? [1 *mark*]
Smooth seed

(ii) What is the expected ratio of wrinkled-seed plants to smooth-seed plants of F_2 generation? [1 *mark*]
1 wrinkled seed : 3 smooth seed
3 smooth seed : 1 wrinkled seed √
1: 3 √
3:1 ***X***

(iii) Using the expected ratio in a (ii), determine the ideal expected number of phenotypes of F_2 generation. [2 *marks*]

Phenotype	Observed number	Expected number
Wrinkled	63	**65**
Smooth	197	**195**

(iv) Determine the dominancy of allele for the seed of pea plants. [1 *mark*]
Wrinkled : **Recessive**
Smooth : **Dominant**
1/0

(v) With the symbol R as dominant allele and symbol r as recessive allele, determine the genotypes of male parent and progeny Q. [2 *marks*]
Male parent : **RR**
Progeny Q : **Rr**

(b) In tomatoes, allele for smooth skin (**L**) is dominant over wrinkled skin (**l**), and allele for red flower (**R**) is dominant over white flower (**r**). A plant that is homozygous for both smooth skin tomato and red flower is crossed with a plant producing wrinkled skin tomato and white flower. A test cross is done on F_1, and the progeny produced are given below.

Smooth skin, red flower	295
Wrinkled skin, white flower	305
Wrinkled skin, red flower	298
Smooth skin, white flower	301

i. Based on the results, draw the cross above. [6 *marks*]

Parental phenotype : **smooth skin, red flower** ~~x~~ **wrinkled skin, white flower** — **1**

Parental genotype : **LLRR** x **llrr**

Gamete : LR, lr — **1**

F_1 genotype : **LlRr**

F_1 phenotype : **smooth skin, red flower** — **1**

F_1 test cross //
F_1 x homozygous recessive: — **1**

(smooth skin, red flower) **LlRr** x **(wrinkled skin, white flower)** **llrr** — **1**

Gametes : LR, Lr, lR, lr, lr — **1**

F_2 genotype : **LlRr** **Llrr** **llRr** **llrr**

F_2 phenotype : **smooth skin red flower** | **smooth skin white flower** | **wrinkled skin red flower** | **wrinkled skin white flower**

3. In a population of 2000 people in an isolated island, 1600 of them are able to roll their tongue into U shape. Ability to roll tongue is controlled by two alleles: T for able for rolling tongue and t for inability for tongue rolling. The population is assumed to be in Hardy-Weinberg equilibrium.
(**All calculation must be in 4 decimal points.**)

(a) Calculate the dominant and recessive allele frequencies. [3 *marks*]

Frequency of homozygous recessive genotype, q^2 $= \frac{400}{2000}$
$= 0.2$ **1**

Frequency of recessive allele, q $= \sqrt{0.2}$
$= 0.4472$ **1**

p + q = 1
Frequency of dominant allele, p $= 1 - q$
$= 1 - 0.4472$
$= 0.5528$ **1**

(b) Calculate the number of people who are heterozygous for this trait. [2 *marks*]

Frequency of heterozygous, 2pq $= 2\ (0.5528)\ (0.4472)$
$= 0.4944$ **1**

Number of heterozygous people $= 2pq \times$ total population
$= 0.4944 \times 2000$
$= 988.8$
$=$ **989 individuals** **1**

(c) State **ONE** assumption of Hardy-Weinberg for genetic equilibrium. [1 *mark*]
Large population// random mating// no mutation// no migration// no natural selection

Large population *X*

4. **FIGURE 4** shows the process in eukaryotic cell.

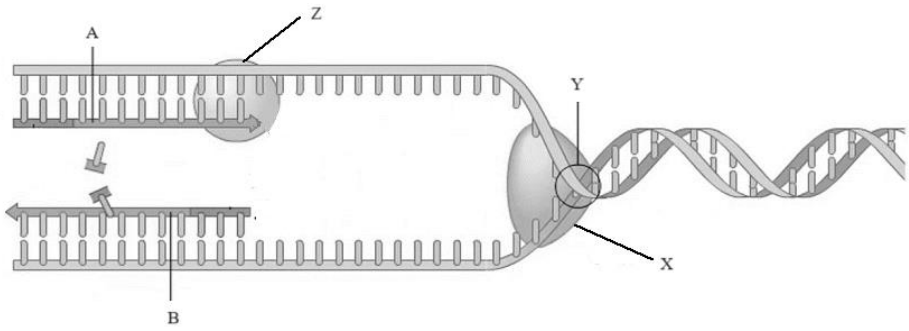


FIGURE 4

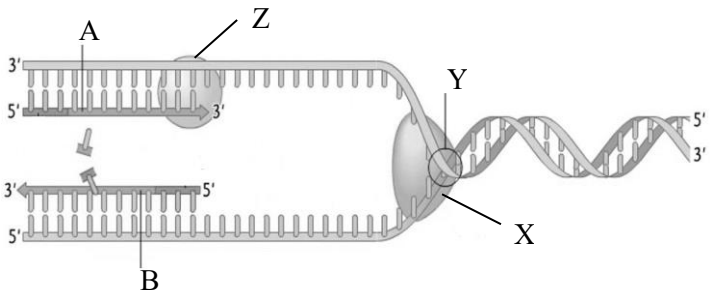
(a) Identify structure label Y and enzyme Z [2 *marks*]
Y : Replication fork
Z : DNA polymerase III

(b) Name the phase of a cell cycle where this process takes place. [1 *mark*]
S phase

(c) i. Name the model of DNA replication in **FIGURE 4**. [1 *mark*]
Semi-conservative model

ii. Explain the model that describes the process shown in **FIGURE 4**. [2 *marks*]
- **Both strand act as template**
- **Each daughter DNA consist of one original strand and one new strand.**

(d) On **FIGURE 4**, label 5'end and 3' end of newly synthesis strand A and B. [1 *mark*]



(e) Why does the synthesis of DNA proceeds only in the 5' to 3' direction? [1 *mark*]
Because DNA polymerase (III) can only add nucleotide to the 3' end of growing polynucleotide chain/ new DNA strand/ primer

(f) What will happened if structure labelled Z cannot perform its function? [2 *marks*]
- **The adding of free DNA nucleotide to the RNA primer cannot happened.**
- **The DNA strand cannot be synthesized // DNA replication does not occur.**

(g) Compare strand A and strand B. [4 *marks*]

Strand A	Strand B	
• **Both require RNA primers to initiate replication**		**1**
• **Both synthesis in 5' to 3' direction**		**1**
Synthesized continuously towards replication fork	**Synthesized discontinuously away from replication fork**	**1**
No formation of Okazaki fragments	**Formation of several Okazaki fragments**	**1** **(Any 2)**
Only one primer required	**Need several primers for synthesis**	**1**

5. **FIGURE 5** shows the formation of polyploid in a plant.

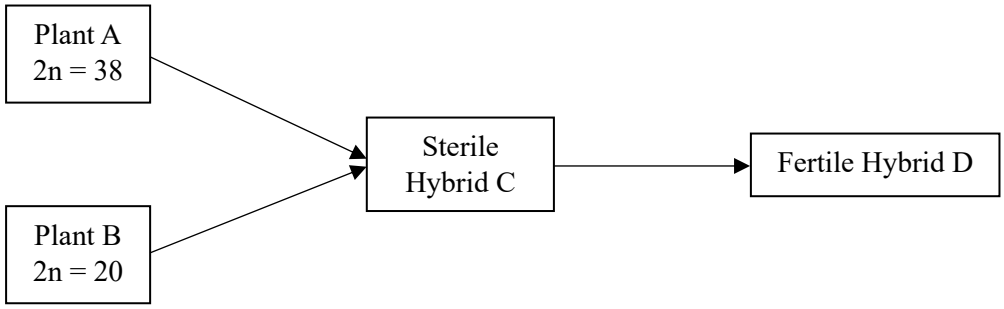


FIGURE 5

(a) i. State the number of chromosomes in hybrid C. [1 *mark*]

29

n + n = 29 √

ii. Describe why hybrid C is sterile and suggest how it can reproduce. [4 *marks*]

- **Homologous chromosomes are not present in hybrid C**
- **Synapsis / meiosis cannot occur.**
- **Gamete cannot be produced // sexual reproduction does not occur.**
- **Hybrid C can produce by asexually reproduction / vegetative propagation.**

(b) Explain how sterile hybrid C produce fertile hybrid D? [3 *marks*]

- **By chromosomal doubling.**
- **Nondisjunction occurs during mitosis.**
- **Homologous chromosome presents in hybrid D.**
- **Synapsis / meiosis occur// Gamete produced**

(c) Name a chemical that can induce polyploidy in crop plants. Briefly describe how this chemical causes polyploidy. [3 *marks*]

- **Colchicine** **1**
- **Colchicine prevents the formation of spindle fibre during cell division.** **1**
- **Nondisjunction occur // homologous chromosome fail to separate during anaphase I /sister chromatids fail to separate during anaphase/anaphase II.** **1** **1** **(Any 2)**
- **Gametes can be produced.**

6. **FIGURE 6** shows the steps in gene cloning using plasmid as vector.

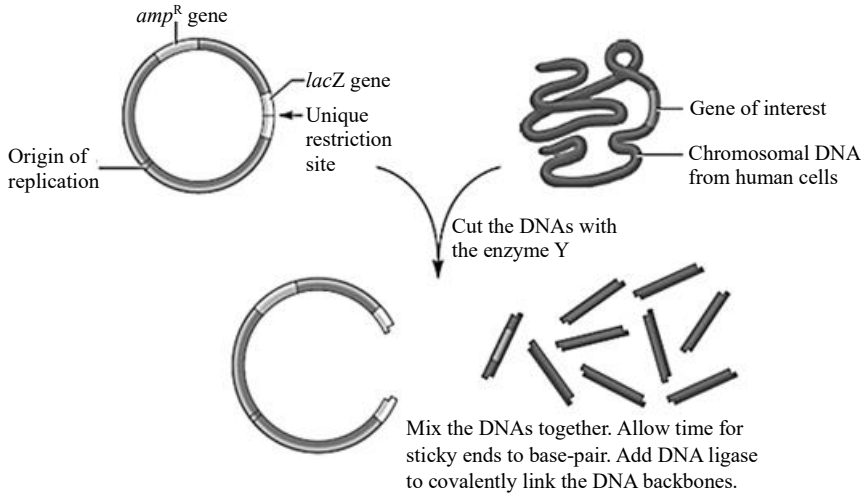
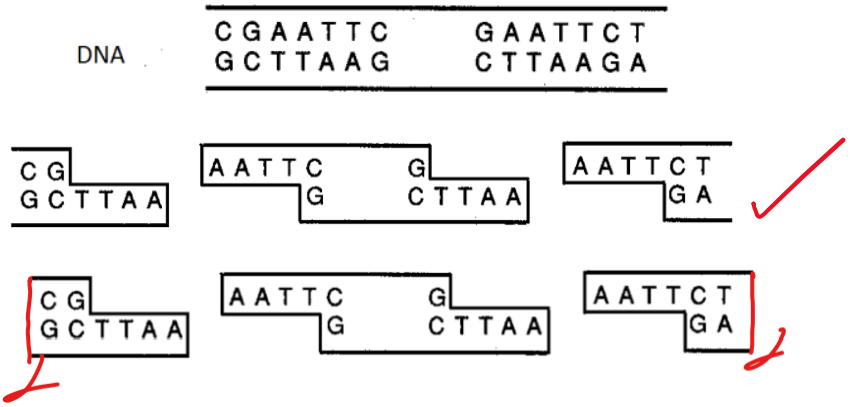


FIGURE 6

(a) Name enzyme Y. [1 *mark*]
Restriction/endonuclease enzyme// *Eco*RI.

(b) Base sequence shown below is a part of chromosomal DNA from the human cell as in **FIGURE 6**. Draw restriction fragments cut by enzyme Y. [1 *mark*]



(c) State the term for the base sequences in the DNA that is cut by enzymes Y. [1 *mark*]
Palindromic sequence.

(d) Reason out the characteristic of plasmid which relate to its structure as follows: [2 *marks*]

Structure of plasmid	Characteristic of plasmid as cloning vector
Presence of *amp*^{R} and *lacZ*	**Possess selectable genetic marker**
Presence of ~~*O*~~*ori* gene/ origin of replication	**Able to replicate freely/autonomously in host cell**

(e) What is the purpose of having *amp*^{R} gene on the plasmid? Briefly explain. [3 *marks*]

- **To screen ~~and~~ /detect/identify/determine the bacteria/host cell contain plasmid that has successfully been inserted with the gene of interest /recombinant plasmid/ recombinant DNA // to determine the ~~recombinant DNA/ plasmid~~. transformant** **1**
- **Host cell/ bacteria will be cultured in medium containing ampicillin.** **1**
- **Host cell/ bacteria with plasmid able to grow because present of *amp*^{R} gene** **1**
- **host cell/ bacteria without plasmid fail to grow because no *amp*^{R} gene/not resistance to antibiotic.** **1**

(Any 2)

(f) Briefly explain the transformation and amplification process. [3 *marks*]

- **Host cell/Bacteria and recombinant DNA/plasmid are mixed in a medium containing calcium chloride ($CaCl_2$)**
- **$CaCl_2$ cause the host /bacterial cell wall to become permeable to take up the recombinant DNA.**
- **The host cells/bacteria undergo amplification by asexual ~~reproduce~~ reproduction/binary fission**

(g) What can be deduced if the colonies appear white during screening? [2 *marks*]

- **The host cell/ bacteria contain recombinant DNA/plasmids.**
- **X-gal not hydrolysed**
- ***lacZ* gene (that encodes for β-galactosidase) is disrupted// β -galactosidase is not produced**

7. (a) Explain the structure of spermatozoa [6 *marks*]

i. **Spermatozoa consists of head, neck, midpiece and tail** 1
ii. **Head contains nucleus and acrosome** 1
iii. **Nucleus is tipped/ capped with acrosome** 1
iv. **Nucleus contains genetic materials** 1
v. **Acrosome contains hydrolytic enzyme** 1
vi. **Neck contains the centrioles** 1
vii. **Midpiece contains a lot of mitochondria** 1
viii. **Tail has 9+2 arrangement of microtubules** 1

Max = 6 *marks*

(b) Explain the stages of spermatogenesis. [8 *marks*]

i.	**Primordial germ cell, 2n (in embryo) divides by <u>mitosis</u> and differentiates into spermatogonial stem cell, 2n**	1
ii.	**Spermatogonial stem cell, 2n divides by <u>mitosis</u> to form two types of spermatogonium, 2n**	1
iii.	**Type A spermatogonium remains at the basal/ basement membrane**	1
iv.	**Type B spermatogonium divides by <u>mitosis</u> and differentiates into primary spermatocytes, 2n**	1
v.	**Each primary spermatocyte, 2n undergoes <u>meiosis I</u> to form two secondary spermatocytes, n**	1
vi.	**Each secondary spermatocyte, n undergoes <u>meiosis II</u> to form two spermatids, n**	1
vii.	**Each spermatid, n undergoes <u>spermiogenesis// differentiation</u> to form spermatozoa**	1
viii.	**During spermiogenesis// differentiation, spermatids elongate, shed excess cytoplasm and form a tail.**	1
ix.	**Spermatozoa are released into the lumen of seminiferous tubule**	1

Max = 8 *marks*

(c) **FIGURE 9** shows the growth curve for human organs.

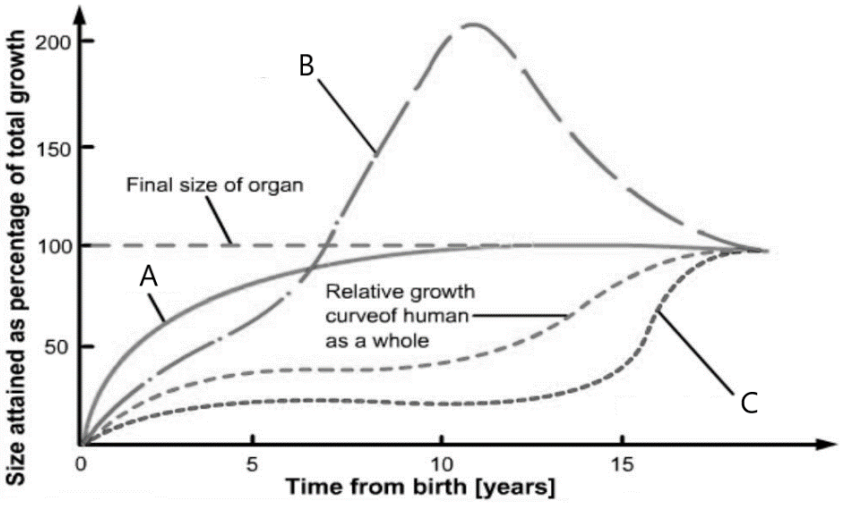


FIGURE 9

(i) Name the growth curve in **FIGURE 9**. [1 *mark*]
Allometric

(ii) Which human organ is represented by curve C? [1 *mark*]
Reproductive organs // testes//scrotum// penis // ovaries // fallopian tubes // uterus // vagina