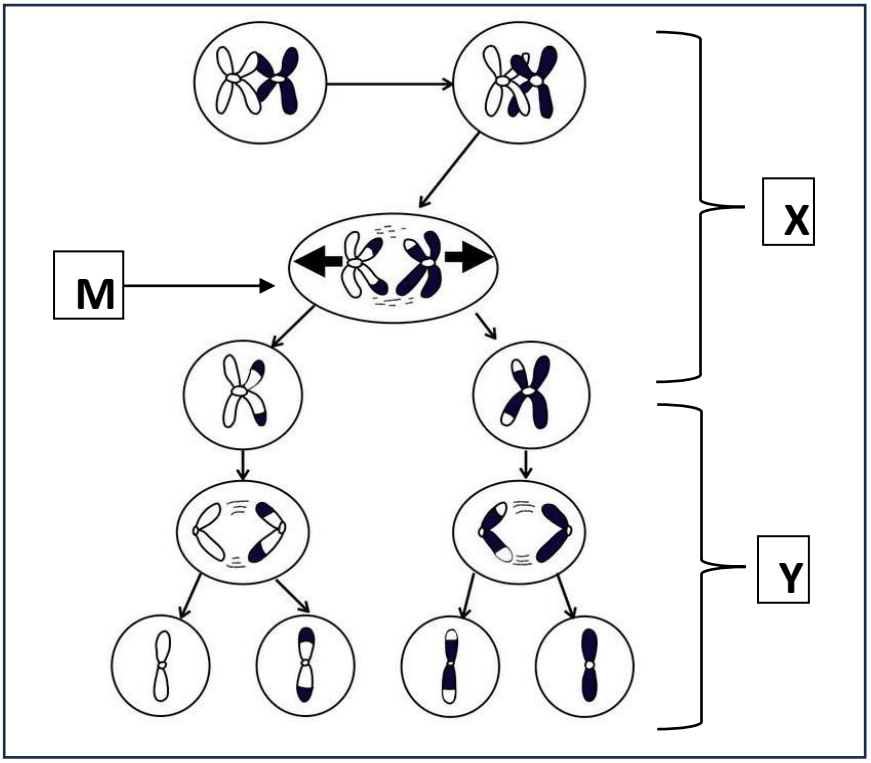
ANSWER SCHEME
BLUE 3 SB015
SESSION 2023/2024

1.	**FIGURE 1** shows meiosis of a diploid cell in cell division.			
				
	FIGURE 1			
	(a)		Name X and Y	[2 *marks]*
			X : Meiosis I **Y : Meiosis II**	**1** **1**
	(b)	(i)	State **stage M** and briefly explain the chromosomal behaviour in the stage	[2 *marks*]
			-Anaphase I **-Homologous chromosomes are separated and moved to opposite pole // Homologous are segregated and pulled to opposite pole**	**1** **1**
		(ii)	State the importance of **stage M** in meiosis	[1 *mark*]
			-To ensure daughter cells contain half the number of chromosomes of the original parent cell	**1**
	(c)	(i)	Explain how genetic materials are exchanged between homologous chromosomes	[2 *marks*]
			-Homologous chromosomes undergo synapsis to form bivalent/ tetrad **-Crossing over occur between non-sister chromatid of homologous chromosome**	**1** **1**

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2. (a) State two Mendel's Laws. [2 *marks*]

-Law of segregation **1**
-Law of independent assortment **1**

(b) (i) In monohybrid cross, Mendel cross pea plant true breeding tall **(TT)** with true breedingshort **(tt).** For the first generation (F1), it was found that all offspring were tall. Draw the genetic diagram completely up to F1. [4 *marks*]

Parental generation: TT x tt ---------- **1 mark**

Gamete: T t ---------- **1 mark**

F_1 generation: Tt

F_1 genotype: Tt ---------- **1 mark**

F_1 phenotypes: Tall ---------- **1 mark**

(ii) Mendel crossed F_1 with F_1 to get the second generation (F_2). Name the cross. [1 mark]

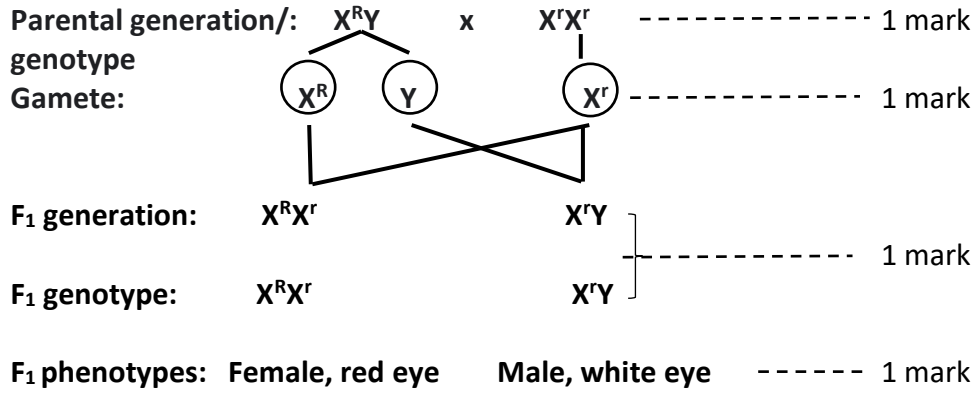
-Self-cross **1**

(c) Differentiate between multiple allele and polygene. [2 *marks*]

Multiple allele	Polygene
One characteristic is controlled by 1 gene with many alleles	One characteristic is controlled by many genes with 2 alleles for each gene
All alleles are located on same locus	All alleles are located on different locus
Only two alleles determine the phenotypes of an individual	All alleles are contributing in determining the phenotype of an individual
No intermediate groups	Has intermediate groups
Discrete distribution curve	Normal distribution curve
Cannot be influenced by environmental factors	Can be influenced by environmental factors

Any two

(d) In fruit flies, eye colour is a sex-linked trait. Red eye is dominant (R) to white eye (r). Show the cross of a white-eyed female with a red-eyed male [4 *marks*]



3 In ladybug population, the spot color of yellow ladybug was controlled by two alleles. The black spot (B) is dominant over red spot (b). In a population of 600 ladybugs, the following data is recorded in **TABLE 3**.

Phenotypes	Genotypes	Number of individuals
Black spot ladybugs	BB	350
Black spot ladybugs	Bb	130
Red spot ladybugs	bb	120

TABLE 3

(a) What is the gene pool size for spot color of the ladybug population? [1 *mark*]

600 x 2 =1200 **1**

(b) What is the frequency of dominant allele, B? [1 *mark*]

Frequency of dominant allele, B = [(350 x2) + 130] / 1200
= 830/1200
= 0.69 ---------- **1 mark**

(c) What is the frequency of recessive allele, b? [1 *mark*]

Frequency of recessive allele, b = [(120 x2) + 130] / 1200
= 370/1200
= 0.31 ---------- **1 mark**

(d) If the ladybugs were left to breed randomly and the population remain in equilibrium, how many individuals are expected to be heterozygous in the next generation of 1500 ladybugs? [3 *marks*]

The expected frequency of heterozygous in the next generation
= 2pq
= 2 (0.69)(0.31)
= 0.428 ----------**1 mark**

Number of heterozygous = 0.428 x 1500 ----------**1 mark**
= 642 ladybugs ----------**1 mark**

4 (a) **FIGURE 4** shows a process that occur before a cell divides.

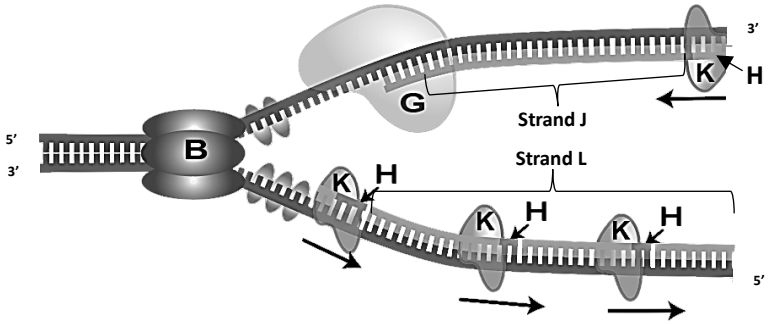


FIGURE 4

(i) Suggest a model that best describe the process shown in **FIGURE 4**. [1 *mark*]

-Semi-conservative/ semiconservative model **1**

(ii) Give **TWO** differences between the synthesis of strand J and strand L in **FIGURE 4**. [2 *marks*]

-Strand J is synthesized continuously (from 5' to 3' end) while strand L is synthesized discontinuously (fragment by fragment from 5' to 3' end). **1**

-Strand J is synthesized towards replication fork while strand L is synthesized away from the replication fork. **1**

-Strand J require only 1 RNA primer while strand L require many RNA primers **1**

-No Okazaki fragments formed in strand J while Okazaki fragments formed in strand L **1**

Max: 2 marks

(iii) Briefly describe the function of enzyme K in the synthesis of strand J and L. [2 *marks*]

-Enzyme K/ Primase synthesise RNA primer **1**

-By adding RNA nucleotides that is complementary to the DNA template **1**

-RNA primer provides a free 3' end for DNA polymerase III to function (add free DNA nucleotides to the 3' end of RNA primer) **1**

Any 1

Max: **2 marks**

(iv) Identify enzyme B and predict what happen if the gene encoded for the synthesis of enzyme B is exposed to a mutagen. [2 *marks*]

-DNA Helicase **1**

-Double stranded DNA cannot be unwound to two single stranded DNA **1**

-DNA replication cannot occur/ take place **1**

Any 1

Max: **2 marks**

(b) Explain transcription and the stages involved in the formation of mRNA strand. [7 *marks*]

i) Transcription is the process where genetic information in DNA is transcribed into an mRNA molecule **1**

ii) During initiation, RNA polymerase binds at the promoter site and unwind the double stranded DNA **1**

iii) Only one strand of the DNA is used as the template for transcription **1**

iv) RNA moves along the unwind strand of DNA **1**

v) During elongation, RNA polymerase adds free RNA nucleotides to the 3' end of the growing strand **1**

vi) That are complementary to the bases of the DNA template strand **1**

vii) Cytosine pair with Guanine and Uracil pair with Adenine **1**

viii) The RNA molecule grows in the 5' end to 3' end direction **1**

ix) The process continue until RNA polymerase reaches termination site on DNA during termination **1**

x) The mRNA strand and RNA polymerase are released **1**

Total: **10 marks**

Max: **7 marks**

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5 (a) Infants with *Cri du chat* syndrome often have a high-pitched cry that sounds like that of a cat while patients with Chronic Myelogenous Leukemia have their bone marrow producing too many white blood cells. Both *Cri du chat* syndrome and Chronic Myelogenous Leukemia are caused by chromosomal aberration mutation.

(i) State the type of chromosomal aberration that cause: [2 *marks*]

Cri du chat: **Deletion**

Chronic Myelogenous Leukemia: **(Reciprocal) Translocation**

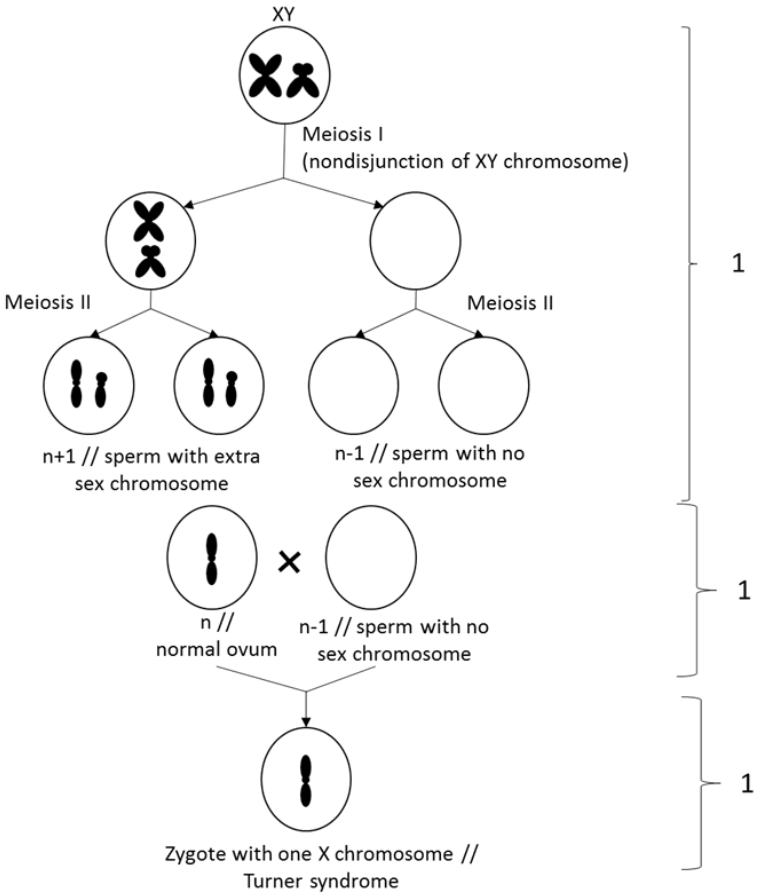
(ii) Give ONE difference between chromosomal aberrations that caused *Cri du chat* and Chronic Myelogenous Leukemia. [1 *mark*]

Chromosomal aberration for *Cri du chat* / Deletion	**Chromosomal aberration for Chronic Myelogenous Leukemia / Translocation**	
i) Involve only one chromosome	**Involve two chromosomes**	**1/0**
ii) Involve chromosome number 5 (in human).	**Involve chromosome number 9 and 22 (in human).**	**1/0**
iii) Involves the loss of a region of chromosome. // do not involved exchange of genetic materials.	**Involves a region of chromosome breaking off and reattach/translocate to a non-homologous chromosome // involved exchange of genetic materials.**	**1/0**

b) Draw a meiotic diagram to show how nondisjunction in meiosis I during spermatogenesis can cause Turner Syndrome. [4 *marks*]

Mark allocation:

1. **Type of chromosome: XY chromosome (label anywhere)**
2. **Drawing of nondisjunction in meiosis I and correct gametes**
3. **Correct drawing of fertilization**
4. **Correct drawing of zygote**



(c) Hybrid Triticum aestivum evolved from hybrid Triticum turgidum through polyploidization. Interbred between Triticum monococcum (2n=14) and Triticum searsii (2n=14) produces hybrid Triticum turgidum which is sterile.

(i) State the chromosome number of Triticum aestivum. [1 *mark*]

(2n=)28 **1**

(ii) Explain why hybrid Triticum aestivum has become a fertile plant. [2 *marks*]

- **Chromosome doubling (by Triticum turgidum)**
- **(Have) homologous chromosome for meiosis // synapsis can occur**
- **Meiosis can occur**
- **Gametes can be produced // Has viable gametes**

Any 2

(iii) Name the type of reproduction carried out by Triticum turgidum. [1 *mark*]

-Vegetative propagation/reproduction // Asexual reproduction **1**

6

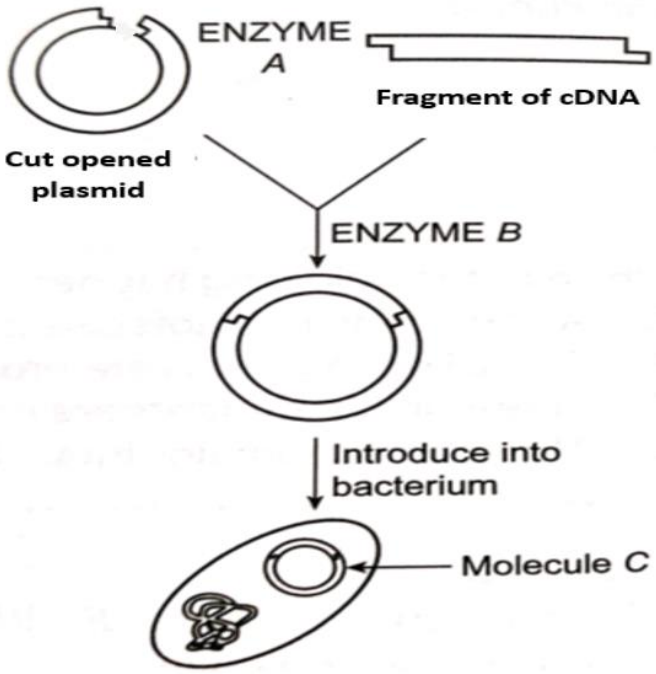


FIGURE 6

The diagram in **FIGURE 6** above is a simplified method used in gene cloning

(a) Give **ONE** example of enzyme A used above [1 *mark*]

-EcoRI // any example of restriction enzyme that produce sticky end **1**

(b) Explain why the same enzyme A is used to cut both plasmid and cDNA? [3 *marks*]

-produce compatible / complementary sticky ends (between (cut) opened plasmid and fragment of cDNA) **1**

-so that (cut) opened plasmid can complementary base pairing with fragment of cDNA **1**

-by formation of hydrogen bonds (between base pairs during insertion process) **1**

(c) Name and explain the function of enzyme B. [2 *marks*]

Enzyme B: **DNA ligase** **1**

Function: **to join / ligate (cut) opened plasmid and fragment of cDNA by formation of phosphodiester bond (to form recombinant DNA / recombinant plasmid / molecule C)** **1**

(d) Bacterial cell with molecule C might be identified as white colonies during screening technique. Describe how white colonies can be form in a medium containing ampicillin and X-gal. [3 *marks*]

-White colonies represent colonies of transformed bacteria / host cell with recombinant plasmid. **1**

-That can survive/ grow in medium containing ampicillin as they have amp^R gene / ampicillin resistance gene (that make them resistant to ampicillin). **1**

-As their lacZ gene is disrupted / non-functional (due to insertion of foreign DNA), they cannot encode production of β-galactosidase **1**

-Thus they cannot hydrolyse X-gal (and become white colonies) **1**

Any 3

(e) Plasmid in **FIGURE 6** above are accidently modified so that foreign DNA are inserted to ampicillin resistance gene. Predict what happen to bacterial cell in **FIGURE 6** above when exposed to medium containing ampicillin? [1 *mark*]

-Bacterial cell do not survive / grow (in medium containing ampicillin as their amp^R gene / ampicillin resistance gene is distrupted / non-functional) **1**

(f) cDNA also can be amplify using PCR technique. Briefly explain this technique. [3 *marks*]

-<u>Denaturation</u> occur as mixture are heated at high temperature about 95^0C (to separate double-stranded cDNA) as each single-stranded cDNA act as template **1**

-<u>Annealing</u> occur as mixture are cooled about 55^0C so that DNA primer able to anneal (and form hydrogen bond) with end of each single-stranded cDNA **1**

-<u>Extension</u> occur about 72^0C as <u>Taq</u> polymerase add DNA nucleotides to 3' end of each DNA primer (by complementary base pairing) forming double-stranded cDNA **1**

7 (a) **FIGURE 7.1** shows a cross section of an embryo sac in a flowering plant

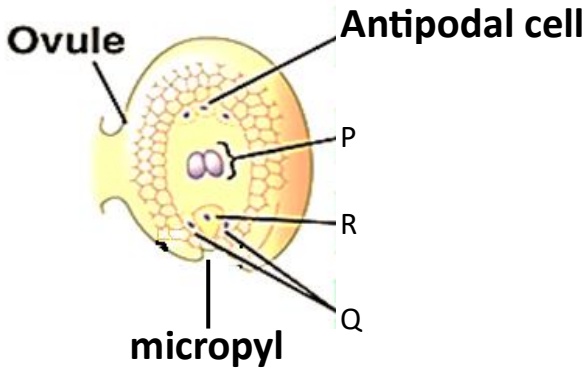


FIGURE 7.1

(i) What type of cell division that produce 8 nuclei of an embryo sac? [1 *mark*]

-(3 times) mitosis **1**

(ii) Name the structure that will be formed after fertilization between [2 *marks*]

a. Male gamete and nucleus of P: **triploid endosperm** **1**

b. Male gamete and nucleus of R: **diploid zygote** **1**

(iii) If the chromosome number of this plant is 28, what is the chromosome number for the structure in ii(a)? [1 *mark*]

-42 **1**

(iv) State the function of cell Q in double fertilization [1 *mark*]

-Attract/guide the pollen tube towards the egg cell/ micropyle in embryo sac **1**

(b) Various stages of the ovarian cycle are shown in **FIGURE 7.2** below.

FIGURE 7.2

Name the phase and describe the hormonal control that occur during **day 1 to day 13** of the ovarian cycle. [7 *marks*]

i) Phase of ovarian cycle: Follicular phase **1**

ii) Begin when hypothalamus secrete Gonadotropin-Releasing Hormone (GnRH) **1**

iii) GnRH stimulates anterior pituitary gland to secrete Follicle-Stimulating Hormone (FSH) and Luteinizing hormone (LH) **1**

iv) FSH stimulates follicle growth (aided by LH) **1**

v) The cells of the growing follicle start to secrete estrogen **1**

vi) There is a slow rise in estrogen level secreted during follicular phase **1**

vii) Low level of estrogen keeps FSH and LH levels slow **1**

viii) Then, secretion of estrogen by growing follicle increases sharply **1**

ix) High level of estrogen stimulates hypothalamus to increase secretion of GnRH **1**

x) GnRH stimulates anterior pituitary gland to secrete large amounts of LH **1**

xi) High level of LH stimulates final maturation of the follicle. **1**

(c) In **FIGURE 7.3** below, M, N and O represent the growth curves of specific human organs and tissues while P represents the growth curve of the human body as a whole.

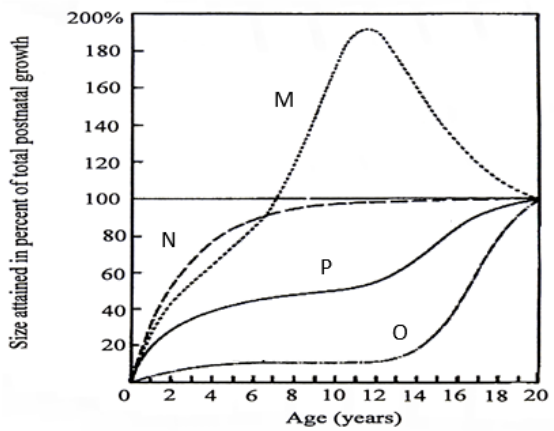


FIGURE 7.3

(i) Name the type of growth pattern shown. [1 *mark*]

-Allometric growth **1**

(ii) Which parts of the body, organs or tissues have the growth pattern shown by [2 *marks*]

a. Curve M: **lymphoid tissue** **1**

b. Curve N: **head** **1**

(iii) Why will the growth rate of a boy slow down and finally become constant after 20 years? [1 *mark*]

-Because the boy is reaching the maturity age. **1**