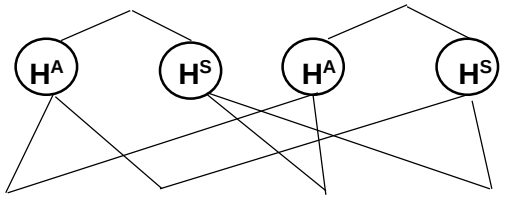
Question	*Answer*	*Mark*
1 (a)	A → C → D → B → F → E	1
(b)	Structure X : Centriole	1
	Function : Organize the formation of spindle fibre	1

(c)

Stage of process	Mitosis	Meiosis I	
Prophase	No synapsis occur// no crossing over between chromosomes// no formation of chiasmata	Homologous chromosomes pair up during synapsis// crossing over occurs//formation of chiasmata// chiasmata hold homologous chromosomes together	1
Metaphase	Chromosome/ sister chromatids align at metaphase plate// sister chromatids of chromosome face each pole// both side of centromere attaches to spindle fiber// no chiasmata	(Pairs of) homologous chromosomes/ bivalent/ tetrad align/ line up/ arranged at metaphase / cell equator/ metaphase plate/ plane// one chromosome of each pair face each pole// only one side of centromere attached to spindle fibre// chia	1 1
Anaphase	Sister chromatids separated and move to the opposite poles	(Pairs of) homologous chromosomes separated and move to the opposite poles	

(d) DNA replication occur once// cytokinesis occurs at the end of the process 1

Question	*Answer*	*Mark*
2 (a) (i)	**Allele is the alternative forms of a gene**	**1**
(ii)	**Parental phenotype : Normal male Normal female**	
	Parental genotype : $H^A H^S$ x $H^A H^S$	**1**
	Gamete : 	**1**
	F_1 genotype : $H^A H^A$ $H^A H^S$ $H^A H^S$ $H^S H^S$	**1**
	F_1 phenotype : Normal Normal Normal Sickle cell Anaemia	
	Explanation:	
	- **Sickle cell anaemia is controlled by recessive allele// Sickle cell anaemia are express by homozygous recessive allele// Sickle cell anaemia condition is recessive phenotype.**	**1**
	- **A mating between heterozygous parent/ carrier genotype parents may formed sickle cell anaemia condition in child.**	**1**
(iii)	**¼**	
(b) (i)	**Sex-linked gene**	**1**
(ii)	Haemophiliac male: **X^hY**	**1**
	A woman with normal blood clotting but have a son with haemophilia: **X^HX^h**	**1**
(iii)	– **His mother is a carrier/ heterozygous**	**1**
	– **Haemophilia is X-linked gene**	**1**
	– **Son always inherit X-chromosome from mother**	**1**
	– **Male only have one X-chromosome**	**1**
		Any 3
3 (a)	**(Extremely) large population size**	**1**
	Random mating	**1**
	No (net) mutation	**1**
	No migration/No gene flow	**1**
	No natural selection	**1**
		Any 2

Question	*Answer*	*Mark*
(b)	**From, $p^2 + 2pq + q^2 = 1$**	
	Frequency of homozygous recessive genotype, q^2 = 20/100	
	=0.20	**1**
	So, frequency of recessive allele, q = $\sqrt{0.20}$	
	= 0.45	**1**
	Since, p + q = 1	
	Frequency of dominant allele, p = 1 – q	
	= 1 – 0.45	
	= 0.55	**1**
	Frequency of heterozygous genotype = 2pq	
	= 2(0.55)(0.45)	
	= 0.50	**1**
	Therefore, the number of heterozygous squirrels in the population	
	= 2pq x 100	
	= 0.50 x 100	
	= <u>50 (squirrels)</u>	**1**
		Max 4

4 (a) (i) **Process A : DNA replication** **1**

Process B : transcription **1**

(ii) **5' UCCGAAUGGCAU 3'** **1**

(iii) **Contain codons that will be translated into polypeptide chain.** **1**

(iv)

Replication	Transcription	
The whole length of the DNA is used as a template	Only a portion of DNA is used as a template	1/0
2 strands of DNA are used as a template	1 strand of DNA is used as a template	1/0
Produces a double stranded DNA	Produces a single stranded mRNA	1/0
Requires DNA polymerase for the formation of DNA strand	Requires RNA polymerase for the formation of RNA strand	1/0
RNA primer is required // Involved primase to start the replication	RNA primer is not required // Does not involved primase to start the transcription	1/0

Any 2

Question	*Answer*	*Mark*
(v)	**The Okazaki fragments cannot be joined (by forming phosphodiester bonds).**	**1**
(vi)	***because DNA polymerase III cannot form a new strand in the 3' to 5' direction// because DNA polymerase III only can synthesizes new strand in the direction 5' to 3'.***	**1**
(b)	**<u>Stage: initiation</u>**	
	i. A small ribosomal subunit binds to an mRNA and moves along the mRNA until it reaches the start codon, AUG	**1**
	ii. An initiator tRNA with anticodon (UAG) base-pairs with the start codon, AUG	**1**
	iii. This tRNA carries the amino acid methionine (Met)	**1**
	iv. The arrival of a large ribosomal subunit completes the initiation complex	**1**
	v. Proteins called initiation factors are required to bring all the translation components together	**1**
	vi. Hydrolysis of GTP provides the energy to the assembly	**1**
	vii. The initiator tRNA is in the P site. The A site is available to the tRNA bearing the next amino acids.	**1**
	Max 6 marks	
5 (a) (i)	**Base substitution**	**1**
(ii)	**Sickle cell anaemia**	**1**
	• **In DNA, base T is replaced with base A // the base sequence in DNA change from CCT to CAT**	**1**
	• **Codon in mRNA change from GAA to GUA // Glutamic acid/ Glu is replaced with Valine/ Val**	**1**
	Any 1	
(b) (i)	**Allopolyploidy**	**1**
(ii)	**18 // n + n = 18**	**1**
(iii)	**Q is sterile because the chromosomes are not homologous/ from different species // Q chromosomes do not pair during meiosis.**	**1**

Question	*Answer*	*Mark*

(c)

Klinefelter syndrome	Turner syndrome	
Aneuploidy condition is Trisomy / 2n+1	Aneuploidy condition Monosomy / 2n-1	1/0 1/0
Male individual	Female individual	1/0
Genotype XXY	Genotype XO	
Individual has 47 chromosomes/ 44 + XXY	Individual has 45 chromosomes/ 44 + XO	1/0 1/0
Underdeveloped testes	Underdeveloped ovary	
Tall / enlarge breast / feminized voice / knocked knees / long limbs	Short stature / webbed neck / poorly develop breasts	1/0

Any 5

6 (a) (i) **Structure Y : Plasmid** **1**

Enzyme : Restriction enzyme/ endonuclease **1**

(ii) **Cut DNA at the same restriction site/specific base sequence** **1**

Produce sticky ends (of the gene of interest and the plasmid vector) that are complementary to each other **1**

(iii) **DNA ligase** **1**

(iv) **Able to accept foreign DNA in multiple cloning site/ MCS** **1**

Able to replicate freely in host cell // present of origin of replication **1**

Has selectable marker gene/ *ampR/ amp^R / lacZ* **1**

Any two

(b)

i. **mRNA only consist exon/ coding sequence of gene//no introns.** **1**
ii. **mRNA is isolated from the target cell** **1**
iii. **The reverse transcriptase enzyme catalysed the synthesis of first DNA strand/ single cDNA using mRNA as a template (and short poly-dT as a DNA primer).** **1**
iv. **mRNA is degraded by another enzyme/ mRNA degrading enzyme** **1**
v. **DNA polymerase is used to catalyse the synthesizes of the second DNA strand/ double stranded cDNA.** **1**
v. **Produce cDNA which carries the complete coding sequence of gene /no intron.** **1**

Any 5

vi.

Question	*Answer*	*Marks*
7 (a)	**First trimester**	
	i. trophoblast cells of blastocyst secrete human chorionic gonadotropin (hCG).	1
	ii. hCG maintains the corpus luteum.	1
	iii. corpus luteum continue to secrete estrogen and progesterone.	1
	iv. estrogen and progesterone maintain the thickening of endometrium for embryonic development.	1
	v. Progesterone level is high to prevent the miscarriage / maintain the pregnancy.	1
	vi. hCG level increases dramatically during the first trimester.	1
	vii. End of first trimester, placenta takes over the roles of corpus luteum to secrete estrogen and progesterone.	1 1
	Any 2 points	
	Second trimester	
	i. hCG secretion declines.	1
	ii. Corpus luteum degenerates.	1
	iii. Placenta completely takes over the production of estrogen and progesterone.	1
	iv. Levels of estrogen and progesterone continue to increase to maintain the thickening of endometrium	1
	v. High level of progesterone inhibits contraction of uterine muscle	1
	Any 2 points	
	Third trimester	
	i. Estrogen reach the highest level during last week of pregnancy	1
	ii. This trigger formation of oxytocin receptor on uterus for preparation of birth process	1
	iii. Progesterone level decreases allow the contraction of uterine muscle.	1
	Any 2 points	

Parturition

i.	**Final week of pregnancy, oestrogen reaches its highest level, which stimulates the formation of oxytocin receptors in the uterus.**	**1**
ii.	**Progesterone level drops off, which stimulates the uterus contraction that will lead to birth.**	**1**
iii.	**Oxytocin released by the fetus and mother's posterior pituitary gland stimulates powerful contraction on uterus.**	**1**
iv.	**Oxytocin also stimulates placenta to secrete prostaglandins, which further enhance uterine contraction.**	**1**
v.	**The contractions stimulate further release of oxytocin & prostaglandins.**	**1**
vi.	**which in turn stimulates further contractions // contraction become stronger and more frequent.**	**1**
vii.	**Action of oxytocin and prostaglandins form a positive-feedback mechanism.**	**1**

Any 6 points

Maximum = 12 marks

(b)	i.	**Secondary oocyte consists of granulosa cells / follicular cells of corona radiata, zona pellucida, plasma membrane, cytoplasm, cortical granule, nucleus and first polar body.**	**1**
	ii.	**<u>Granulosa cell</u> is secretory cells in Graafian follicle that surrounds the oocyte**	**1**
	iii.	**It supplies nutrients to the developing oocyte**	**1**
		Any one	
	iv.	**<u>Zona pellucida</u> is a layer of glycoprotein that surround plasma membrane of a mammalian egg cell.**	**1**
	v.	**It develops as a jelly coat**	**1**
		Any one	
	vi.	**<u>First polar body</u> is a small cell produced in meiosis I during development of oocyte (and finally degenerates).**	**1**

Maximum: 4 marks

TOTAL MARK **80**