

The question paper is divided into 3 SECTIONS (A/B/C). Answer all parts of the same section together.  
 Provide justification wherever asked; no justification, NO marks

**Section "A"**

**Q1. a.** Three tissue samples (pre-weighed) were placed in different test tubes (A-C), each containing sucrose solution of different concentration. After 1 hour, the final weight was recorded (see table). Based on the results, identify the type of solution used in each test tube. Justify your answer. **[1.5]**

Test Tube	Initial tissue weight (g)	Final tissue weight (g)
<b>A</b>	1.95	1.71
<b>B</b>	1.29	1.29
<b>C</b>	1.55	1.88

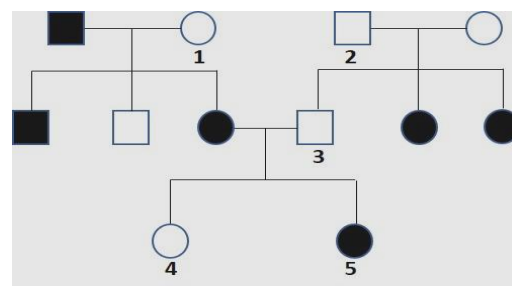
**b.** *Ophioglossum reticulatum* (Adder's-tongue fern) has largest number of chromosomes (n=630) in plant kingdom. Mention the cell cycle stage during which you can clearly identify 2520 chromatids in the somatic cells of this plant. Justify your answer. **[1.0]**

**c.** A researcher is studying Golgi apparatus in animal cells. He finds a dye that specifically labels the Golgi membrane. He stained the cells with this dye and observed under microscope. In some cells, the dye labeled only Golgi, and he clearly observed intact stacks of Golgi structures. While, in some other cells, he found that the dye apart from staining the Golgi apparatus also stained the plasma membrane and lysosomes. Justify the observation. **[2.0]**

**Q2. a.** The first cat was cloned following SCNT procedure in 2001, at Texas A & M University. 'Rainbow' was the original, cat and the cloned cat was named 'CC' (carbon copy). Though the cloning was successful, surprisingly the researchers observed that 'CC' does not look like 'Rainbow'; 'CC' had a completely different coat pattern. Write the most probable reason for the above. If 'CC' is further cloned, do you expect a similar fate in this cloned cat as well? **[3.0]**

**b.** While analyzing DNA in an animal cell, a researcher observes that some portion of a single DNA strand also has RNA nucleotides incorporated in it, though for a short time. When can you expect such a state naturally in a cell? **[1.5]**

**Q3. a.** For the given pedigree, deduce the most likely mode of inheritance (autosomal/sexlinked/dominant/recessive). Justify your answer. Write the probable genotypes of the numbered individuals. **[3.0]**



**b.** In human, the presence of black eyeball is due to a dominant allele (B) and brown eye is due to its recessive allele (b). Similarly, cleft in chin (T) is dominant over no cleft (t). A couple with black eye and cleft chin have two children. One has black eye but no cleft and the other has cleft chin but brown eyes. Write the genotype of the parents. What are the chances that they would have a child with brown eyes and no cleft (provide a number for your answer)? Show the Punnett square and how you derive your conclusion. **[3.0]**

**Section "B"**

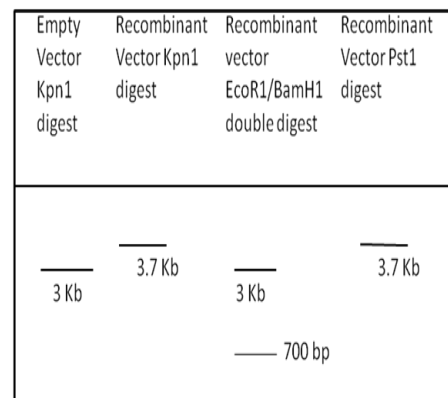
**Q4. a.** The given image represents a gel with pattern of bands obtained after a plasmid (with or without a cloned gene) is restriction digested. Based on the given figure, draw a diagram of the plasmid clearly depicting the insert and all the restriction enzyme digestion sites on it. Note that Pst1 do not cut the empty vector. **[2.0]**

**b.** Kanamycin is an antibiotic. It inhibits bacterial growth by interfering with ribosome function. As ribosome is required for protein synthesis of human as well, why does this drug not affect humans (directly) consuming it? **[2.0]**

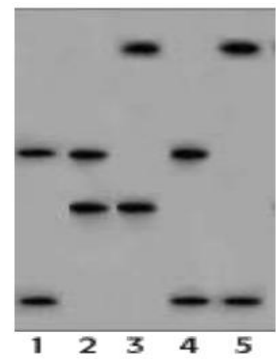
**Q5.** Replication requires the following components: (a) DNA polymerase; (b) Primase; (c) Helicase; (d) Gyrase/Topoisomerase; (e) DNA nucleotides; (f) RNA nucleotides; (g) Ligase; and (h) other replication associated proteins binding to the origin of replication (ORI) sites. Given that PCR is based on the principle of replication

**a.** Enlist the components (from the above) that are required for a successful PCR. Justify your answer. **[1.0]**

**b.** Provide reasons for each component eliminated. **[3.0]**



c. The given figure shows the DNA fingerprint for a STR site in a family that consists of a father, mother, and three children. The second lane represents the DNA fingerprint of the mother. Which lane represents the DNA fingerprint of the father? Justify your answer. [2.0]



Q6. Given below is a sequence of an mRNA present in a eukaryotic cell.

mGGAGA-----AUG-----UAG-----AAAAAAAAA

a. Copy the mRNA in your answer sheet and mark the exact region of the 5' and 3' UTR. [1.0]

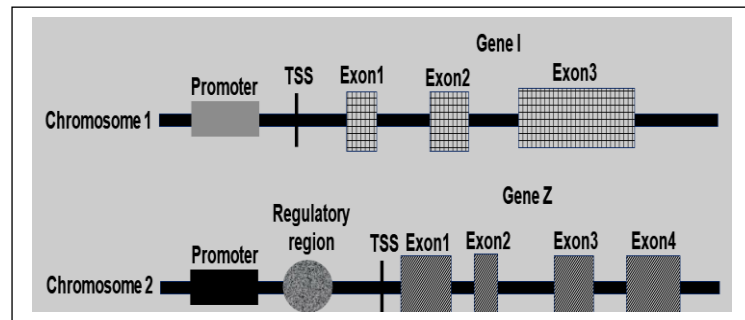
b. What may happen with the fate of RNA if the underlined sequence is removed? [1.5]

Q7. A plant ( $2n=4$ ) is homozygous recessive for gene A and heterozygous for gene B. These two genes are very closely located on the same chromosome (#1). It is also heterozygous for gene Q, which is located on a separate chromosome (#2). Through sketched diagram show all possible ways this plant's chromosomes could be arranged during metaphase of meiosis-I. Label chromosomes and alleles. Ignore the possibility of crossing over. [3.0]

### Section "C"

Q8. As you follow the movement of five distinct components (A, B, C, D and E) through kidney, you found that four of them- 'B, C, D and E' could pass through the glomerular filtration barrier to form the filtrate, while 'A' could not pass. You also observed that as these components pass through the initial part of the kidney tubule, 'B, C and D' are reabsorbed. Interestingly, 'C and D' in the filtrate simply follow the path that 'B' decides during the re-absorption. In contrast, 'E' NEVER gets reabsorbed in any part of the kidney tubule. In addition, upon further biochemical analysis you found that component 'A' is the polymeric form of 'C'. Based on these information, predict the names of 'A, B, C, D and E' with appropriate justification for your choices. [4.0]

Q9. A eukaryotic cell carries two chromosomes (Chromosome 1 and 2). They have 'Gene I' on Chromosome 1 and 'Gene Z' on Chromosome 2 (see diagram). The product of Gene I binds to the regulatory region of Gene Z and stops transcription of Gene Z, even if the promoter of Gene Z is active. Interestingly, Gene I promoter is temperature sensitive, allowing the expression of Gene I product only when the cell is kept at temperature of more than  $38^{\circ}\text{C}$ . Based on these information, what will be expression status (expressed or not expressed) of Gene I and Z transcripts under below circumstances. Justify. (TSS: Transcription start site). [0.5\*4=2]

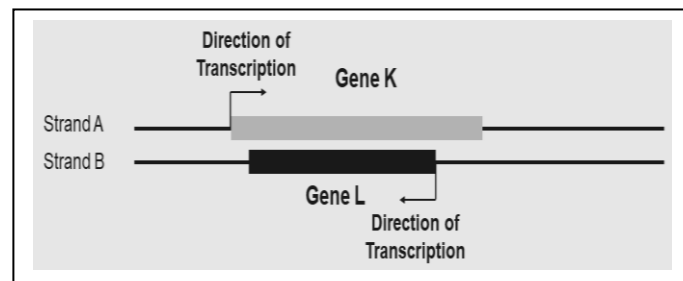


- Promoter region of Gene I is in euchromatic (open) state while the incubation temperature is  $37^{\circ}\text{C}$ .
- The promoter of Gene Z is in heterochromatin state while the cell has been incubated at  $38.2^{\circ}\text{C}$ .
- The regulatory region of Gene Z is mutated (nonfunctional); promoter is in euchromatic state; cell is cultured at  $39^{\circ}\text{C}$ .
- The protein product of Gene I is misfolded.

Q10. The given figure indicates the presence of two genes (K and L) in a chromosome from an organism. Redraw the given figure in your copy, and answer the following questions-

- Write the polarity of the strands A and B.
- Approximate location of the promoter region for Gene L.
- Approximate location of transcription termination site of Gene K.
- The coding strand for Gene K.
- The template strand for Gene L.

[0.5\*5=2.5]



Q11. Your friend is exploring drugs that can modify an action potential or synaptic transmission. In each of the following cases, if he uses a unique drug, specify the most probable target (ion/molecule/protein) for the drugs. Justify. [1.0\*2=2.0]

- The drug inhibits the effect of GABA without affecting its synthesis/release/binding/stability at the synapse.
- The drug prevents release of neurotransmitter at synapse without affecting its synthesis/stability/storage in vesicles.

Q12. a. Why non-gonadal steroid hormones (NGSH) are often given to kidney transplant patients? Mention the natural source of these NGSH in human. [2.0]

b. Thyroxine can increase metabolism, however, excess intake of thyroxine can affect its natural synthesis. Why? [2.0]