Test Code: RHG-I (Short answer type) & RHG-II
2012
Junior Research fellowship in Human Genetics,
Indian Statistical Institute

Syllabus

1. Cell growth, Division, Differentiation, Senescence, Metabolism of protein, carbohydrate and lipids in relation to diseases.

2. Replication, Transcription, Translation, Genetic code & protein synthesis, Enzymes, Co-enzymes, Receptor mediated cell functions, regulation of gene expression

3. Cancer genetics and etiological and genetic factors for different types of cancers. Mitochondrial genetics and diseases.

4. Population genetics, genetics of single and multi loci diseases

5. Modern methodologies in cell/tissue culture, Chromosome staining, PCR, ELISA, Immunocyto/histochemical techniques, Hybridization techniques and other molecular biology techniques, DNA sequencing, Immuno CHIP assay etc.

6. Gene therapy and modification of gene expression (anti-sense RNA, RNAi/miRNA, chromatin remodeling) transgenic and knockout mouse, tissue specific knock-out of gene

7. Cancer biology, Abnormal cell growth, Oncogenes & Tumour suppressor genes, Programmed cell death, Cell signaling, Immunomodifiers

8. Basic Statistics: Mean, Median, Mode, Standard deviation, Correlation and Regression, Simple probability calculations

9. Biostatistics: Chi- square and ‘t’ test, Hardy-Weinberg equilibrium law, Linkage Disequilibrium

Sample Questions RHG-I (Objective types)

1. A major deviation from Mendel's Laws occurs because of

   O Linkage
   O Mutation
   O Reversion
   O Complementation

2. A Characteristic property of stem cells

   O Metastasis
   O Terminal differentiation
   O Self-renewal
   O Senescence

3. Three polypeptides (A, B and C) whose masses are 55 kDa, 50 kDa and 75kDa with pI of 6.5, 7.0 and 8.0 respectively, were subjected to standard reducing SDS-PAGE. The order of their separation from top to bottom would be

   O A, B and C
   O B, A and C
   O A, C and B
   O C, A, and B

4. Which mutation cannot occur in a tRNA encoding gene?

   O deletion
   O Transition
   O Transversion
   O Nonsense mutation

5. The direction of migration of the tripeptide Lys-Lys-Lys in an electric field at pH=3 and pH=10 is

   O Cathode and cathode respectively
   O Cathode and anode respectively
   O Anode and cathode respectively
   O Anode and anode respectively

6. An X-linked recessive gene produces red-green color blindness in humans. A woman with normal color vision, whose father was color blind, marries a color blind man. What is the probability that their son will be color blind?

- O 1/4
- O 1/2
- O 3/4
- O 1

7. Two-hybrid analysis is used for:

- O Studying DNA-protein interactions
- O Studying protein-protein interactions
- O Studying regulatory proteins
- O Identification of complementary stands of nucleic acids

8. Which of the following types of bonds or interaction are LEAST likely to be involved in stabilizing the three-dimensional folding of most proteins?

- O Hydrogen bonds
- O Disulfide bonds
- O Ester bonds
- O Disulfide bonds

9. One important mechanism for maintaining sequence identity among the many copies of a gene within a tandem array is

- O Unequal crossing-over
- O Gene conversion
- O Retrotransposition
- O Inversion

10. The synthesis of mRNA's that encode the proteins of eukaryotic ribosomes occurs in the

- O Euchromatin
- O Heterochromatin
- O Cytoplasm
- O Nucleolus

Sample Questions: RHG-II (Descriptive type)

1. Phenylketonuria (PKU) is a rare autosomal recessive disease. A couple who are both normal, decided to have children. The man has a brother with PKU and the woman has a sister with PKU. There are no other known cases in the family.
   a) Deduce the genotypes of the man's brother and woman's sister.
   b) What are the genotypes of the man and woman's parents?
   c) What is the probability that the couple's first child will have PKU?

2. What are the processes involved in X-chromosome inactivation in mammals?

3. a). Many cancers seem to involve environmental factors. Why, then, is cancer called a genetic disease?
   b). Discuss how programmed cell death / apoptosis participates in maintaining cellular homeostatis. Explain why DNA from apoptotic cells show up as 200bp ladder in agarose gels.

4. Describe how mRNA translation is initiated and terminated. Why is the genetic code a triplet instead of doublet or singlet code, considering the fact we have 20 different amino acids? How many different amino acid sequences are possible in a polypeptide 146 amino acids long?

5. Describe characteristic features of mismatch, base-excision and nucleotide excision repairs with examples.