

**Test Code: RHG-I (Short answer type) & RHG-II
(Descriptive type) 2009**

Junior Research fellowship in Human Genetics

Syllabus

1. Cell growth, Division, Differentiation, Senescence
2. Metabolism of protein, carbohydrate and lipids in relation to diseases.
3. Replication, Transcription, Translation, Genetic code & protein synthesis, Enzymes, Co-enzymes, Receptor mediated cell functions, regulation of gene expression
4. Cancer genetics, etiological factors for different types of cancers
5. Population genetics, genetics of single and multi loci diseases
6. Modern methodologies in cell/tissue culture, Chromosome techniques, PCR ELISA, Immunocyto/histochemical techniques, Hybridization techniques and other molecular biology techniques
7. Gene therapy and modification of gene expression (anti-sense RNA, RNAi/miRNA, chromatin remodeling) transgenic and knockout mouse, tissue specific knock-out of gene; genomics and proteomics
8. Cancer biology, Abnormal cell growth, Oncogenes & Tumour suppressor genes, Programmed cell death, Cell signaling, Immunomodifiers
9. Basic Statistics: Mean, Median, Mode, Standard deviation, Correlation and Regression, Simple probability calculations
10. Biostatistics: Chi- square and 't' test, Hardy-Weinberg equilibrium law, Linkage Disequilibrium

RHG-I (2009): Short questions: Answer any eight (8X10)

Total: 80, Time: 2hr.

1. Consider an autosomal locus with three alleles A1, A2 and A3. Suppose the frequencies of the alleles in a random mating population are 0.6, 0.3 and 0.1, respectively. What is the total frequency of heterozygotes at this locus in this population?
2. Genomic clone of glutamine synthetase is cleaved into two fragments by Hind III enzyme whereas the same enzyme does not cut full-length cDNA clone of this gene. Explain these results.
3. Which specific repair pathway (s) is/are primarily responsible for repairing the following types of damage:
a) AP site; b) T-G mismatch; c) cyclobutane pyrimidine dimers; d) double-strand break
4. If, on an average, there were one nucleotide change per 1kb of DNA per one million years, how many nucleotide changes would you expect if you compared 10kb of two DNA sequences that diverged from each other 10 million years ago?
5. Let Y denote the total length (number of nucleotides) of all introns of a gene and X denote the total length (number of nucleotides) of all exons of a gene. Suppose for a set of genes it is found that $Y=X^2$, what is the correlation between the total intron length and the total exon length of these genes?

6. A hospital-based survey indicates 35% of patients have high blood pressure, 53% have heart trouble, and 22% have both blood pressure and heart trouble. What is the probability that a patient selected at random has,
 - a) At least one of the two ailments?
 - b) Exactly one of the two ailments?
 - c) None of the two ailments?
7. A mutation in an essential human gene changes the 5' splice site of a large intron from GT to CC, predict the phenotype of an individual homozygous for this mutation.
8. Describe three types of post-translational regulations?
9. Both embryonic and cancer cells divide quickly -: how can these two types of cells be distinguished?
10. What are CpG islands? What are the important roles played by CpG islands in the human genome?

**RHG-II (2009): Descriptive questions: Answer any five
(16 X 5): Total marks 80. Time: 2hr**

1. The frequency of newborn infants homozygous for a recessive lethal allele is 1 in 25,000. What is the expected frequency of carriers of this allele in the population?
2. Consider the autosomal blood-group system called MN, which is controlled by a pair of alleles (M and N). In a random mating population, what fraction of children with the MN blood group is expected to have MN mothers?
3. Explain Lambert- Beers Law. Why does the absorbance of equimolar amounts of tryptophan and tyrosine differ, at 280 nm? Explain why mutation of a protein can lead to change in absorbance at 280nm?
4. Phenylketonuria (PKU) is a rare autosomal recessive disease. A couple who are both normal decide 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?
5. What are the processes involved in X-chromosome inactivation in mammals?

6. What is meant by an epigenetic modification? Name 4 modifications to histones that are believed to affect gene expression. How might these modifications, in general affect chromatin structure and gene expression?
7. Calculate the number of copies of genome present in 1mg of human haploid DNA and the weight of one copy of human genome. (The human haploid DNA contains 3×10^9 nucleotide pairs (np) and the average molecular weight of a nucleotide pair is 660).