



**RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES**

**B.Sc. in Applied Sciences
Second Year – Semester II Examination – September/ October 2020**

BIO 2203 – GENETICS & EVOLUTION

Time: Two (02) hours

Answer Four (04) questions including question number 1.

1. Multiple choice questions. Answer all sections in this question by underlining the most appropriate option with a pen.

- a) Which of the following is a hypothesis of Mendel?
 - i. During gamete formation, segregating pairs of factors assort independently of each other.
 - ii. During the formation of gametes, the paired factors segregate, randomly so that each cell receives one or the other with equal likelihood.
 - iii. Hereditary characteristics are controlled by factors that exist in pairs in individual organisms.
 - iv. All of the above
- b) The phenotype of an organism is determined by the
 - i. genotype
 - ii. environment
 - iii. nutrients and genotype
 - iv. genotype and environment
- c) Regulatory region of a gene
 - i. signals the end of the gene.
 - ii. controls the transcription of the gene.
 - iii. does not code for a functional gene product.
 - iv. codes for a functional gene product.
- d) Mobile genetic elements or transposons are segments of DNA
 - i. that control the transcription of the gene.
 - ii. codes for a functional gene product.
 - iii. that copy and insert themselves to other regions of the genome.
 - iv. that copy and insert themselves to genomes of other organisms.

- e) A normal cell is transformed into a cancer cell when the genes that regulate cell growth and differentiation is altered. Of the following, what combination comprises the genes that regulate cell growth and differentiation?
- Oncogenes, Tumor suppressor genes
 - Oncogenes, Epistatic genes
 - Tumor suppressor genes, pleiotropic genes
 - Tumor suppressor genes, X-chromosome linked genes
- f) In fruit flies, eye colour is X-linked and red eye colour is dominant to white eye colour. Which of the following are not possible in a cross between a red-eyed male and a heterozygous female?
- Red-eyed male.
 - White-eyed male.
 - Carrier female
 - White eyed female
- g) Sometimes a mutation in a single gene can cause a disease with a wide range of symptoms. What genetic phenomenon could cause such a condition?
- Epistatic interaction
 - Multifactorial disease
 - Pleiotropic interaction
 - Co-dominance
- h) In a dihybrid cross between fruit flies, the total recombinant progeny was 70 out of a total progeny of 400. The recombination frequency of the two different genes in concern is
- 20.4%
 - 19.6%
 - 18.5%
 - 17.5%
- i) Biological evolution can be defined as
- changes observed in an organism during the process of growth and development.
 - the survival of the fittest
 - change in the gene frequency from one generation of a population to the next.
 - a process that always enhances the adaptability of organisms to their environment.
- j) The concept of catastrophism was proposed by
- Jean Baptiste Lamarck
 - J B S Haldane
 - James Hutton
 - Georges Cuvier

j) Which of the following processes contributes to genetic drift

- i. Microevolution
- ii. Variation in family size
- iii. Speciation
- iv. Disruptive selection

k) Allopatric speciation is facilitated by

- i. Mutation
- ii. Pre and post zygotic barriers
- iii. Synapomorphies
- iv. Stabilization selection

l) Primate forelimbs and avian wings are an example for

- I. Convergence
- II. Parallel evolution
- III. Analogous structures
- IV. Homologous structures

m) The theory of use and disuse of body parts was proposed by

- I. Charles Lyell
- II. James Ussher
- III. Alfred Russel Wallace
- IV. Sewall Wright

n) When reconstructing phylogenies, the most informative characters are

- A. Convergent
- B. Analogous
- C. Synapomorphies
- D. Sympleiomorphies

(4 x 15 = 60 marks)

2. a) Describe briefly, the term gene expression. (10 marks)
- b) State the two main strategies used in regulation of gene expression. (10 marks)
- c) Using appropriate examples, describe how prokaryotes regulate gene expression using the above two methods. (80 marks)

3. The ear tuft allele in chickens is an autosomal gene that produces feathered skin projections near the ear on each side of the head. The dominant allele (T) that causes the ear tufts is lethal (deadly) in the homozygous state, and thus the embryos having the two dominant alleles never hatch from the eggs. In a population of 10000 chickens, 4000 have no ear tufts while 6000 have ear tufts.

- a) Calculate the frequencies of the ear tuft alleles (T) and the normal alleles (t). **(30 marks)**
 - b) What are the assumptions of the Hardy-Weinberg equilibrium? **(25 marks)**
 - c) If the population is in Hardy-Weinberg equilibrium, what would be the genotype frequencies in the next generation? **(25 marks)**
 - d) Is it possible to consider this population to be under Hardy-Weinberg equilibrium? Give reasons for your answer **(20 marks)**
4. The big horn sheep (*Ovis canadensis*) is a species of sheep that is endemic to North America. Male sheep (rams) possess large horns and have been subjected to controlled hunting for several decades. Hunters prefer to hunt males with large horns. A study was conducted by Coltman *et al.* (2004) to examine the impact of long-term hunting pressure on certain phenotypic characters of the *Ovis* population, the results of which are summarized in the figure below.

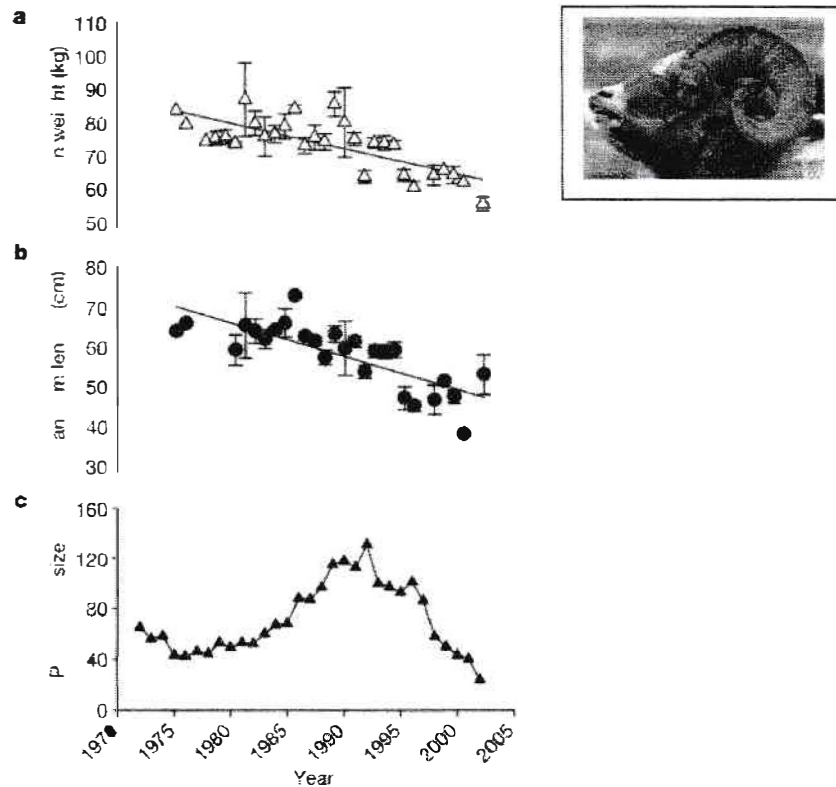


Figure 01. Observed changes in mean weight and horn length and in the population size from 1972 to 2002. **a**, Relationship between weight (mean \pm s.e.m.) of 4-year-old rams and year (N=133 rams). **b**, Relationship between horn length (mean \pm s.e.m.) of 4-year-old rams and year (N=119 rams). **c**, Changes in population size over time.

(Source. David W. Coltman, Paul O'Donoghue, Jon T. Jorgenson, John T. Hogg, Curtis Strobeck & Marco Festa-Bianchet. 2004. Undesirable evolutionary consequences of trophy hunting. Nature 426: 655-658)

- a) Briefly comment on graphs a, b and c in figure 01. **(20 marks)**
- b) Using your understanding of the principles of evolutionary biology, provide a plausible explanation for the trends seen in graphs **a** and **b**. **(80 marks)**
5. There is considerable debate among biologists on the validity of different species concepts. Yet, there is a general consensus among scientists that all species concepts should possess certain common characteristics. Briefly discuss the biological species concept and its limitations and comment on the criteria that should be common to all species concepts. **(100 marks)**

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