ASSIGNMENT
(Tutor Marked Assignment)

Course Code: MZO-004
Assignment Code: MZO-004/TMA/2026
Maximum Marks: 100

Note: Attempt all questions. The mark for each question is indicated against it.

1. (a) Explain how the principles of evolutionary biology account for antibiotic resistance in bacteria and highlight its broader applications in science and society. (5)

   (b) Describe how the Big Bang theory, formation of Earth, and the concept of chemical evolution together explain the origin of life on our planet. (5)

2. Explain the key features and representation of phylogenetic trees, including nodes, branches, root, terminal nodes, outgroup, scaled (phylogram) and unscaled (cladogram) trees, rooted and unrooted trees, polytomy, and monophyletic, paraphyletic, and polyphyletic groups. (10)

3. Describe the key features, variability, and biological significance of bacterial genomes, including operons, plasmids, *PHX* genes, and adaptations in *Deinococcus radiodurans*. (10)

4. Explain the role of plasmids in horizontal gene transfer in bacteria, including F, Hfr, and F' plasmids, and their significance in antibiotic resistance, virulence, and genetic recombination. (10)

5. (a) Explain the two models proposed for the origin of the endoplasmic reticulum (ER) in eukaryotes and discuss how ER evolution is linked to the development of protein secretion pathways and the Golgi apparatus. (5)

   (b) Describe how mitosis, meiosis, and sexual reproduction likely evolved in early eukaryotes, and explain how diploidy and meiosis provide survival and genetic diversity advantages. (5)

6. Explain the theory of endosymbiosis and describe how primary endosymbiosis led to the origin of mitochondria and chloroplasts, including gene transfer to the host nucleus and loss of independence of these organelles. (10)

7. (a) Explain the differences between Artificial, Natural, and Phylogenetic systems of classification, giving examples and their importance in studying relationships and evolution of organisms. (5)

   (b) Explain the components of taxonomy and describe the different types of taxonomy, including classical, modern, and molecular approaches, with suitable examples. (5)

8. (a) Discuss the role of cyanobacteria in transforming Earth's early environment and explain how this change influenced the evolution of complex life forms. (5)

   (b) Differentiate between catastrophic, mass, and background extinctions with suitable examples from Earth's history. (5)

9. Discuss the unique anatomical and genetic traits that distinguish modern humans from other hominins and great apes. (10)

10. Describe the following: (2½×4=10)

a) RNA World hypothesis

b) Molecular drive

c) Evolution of gene families

d) Sympatric speciation

1. (a) Explain how the principles of evolutionary biology account for antibiotic resistance in bacteria and highlight its broader applications in science and society. (5)

Answer

Antibiotic resistance is one of the clearest examples of evolution occurring on a human time scale. A bacterial population is not genetically uniform. New variants arise by mutation, and bacteria can also acquire genes from other cells through horizontal gene transfer. Some variants may alter a drug target, reduce uptake of the drug, increase efflux, produce an enzyme that destroys the antibiotic, or change a metabolic pathway. These variants do not arise because the bacterium ‘needs’ resistance; they arise before or during exposure and are then sorted by selection.

Natural selection and spread of resistance

When an antibiotic is used, susceptible cells are killed or their growth is stopped, while resistant cells survive better. The survivors reproduce rapidly and pass the resistance determinant to their descendants. Repeated exposure therefore changes allele and genotype frequencies in the population. Resistance can spread even faster when genes are carried on plasmids, transposons or other mobile elements and transferred between unrelated bacteria. Strong or repeated antibiotic use creates intense selective pressure, while inadequate dosing, unnecessary prescriptions and widespread agricultural use increase opportunities for resistant lineages to persist and spread.

Resistance can carry a fitness cost when the drug is absent, but compensatory mutations may reduce that cost and allow resistant strains to persist. The same evolutionary reasoning supports antibiotic stewardship, combination therapy and treatment designs that reduce the chance that a resistant variant will dominate.

Broader applications

The same principle explains pesticide and herbicide resistance, antiviral resistance and the evolution of cancer cells under chemotherapy. Evolutionary thinking also guides vaccine design and pathogen surveillance. Antibiotic resistance has a social dimension because misuse by individuals or institutions can select variants that later spread through hospitals, communities and food systems. Evolutionary biology therefore provides a practical framework for medicine, agriculture and public health.