EVOLUTION. Learning Objectives

Students should be able to:

Introduction to Evolution

• define biological evolution.

• Distinguish what evolves in the biological world

History of the Evolution Theory

• identify early naturalists and discuss their contributions to evolutionary theory.

• Discuss how Darwin's observations of nature led to the inferences he developed regarding natural selection.

Methods in Evolution

• Explain the role the fossil record played in the development of the concept of evolution.

• using evidence from fossil whales, explain how lineages change through time.

• Describe how radioactive elements are used to determine the age of rocks.

• explain how the fossil record relates to patterns of fossilization.

• Discuss why different lines of evidence are important in examining earth's history.

• Describe the earliest forms of life on earth.

• Describe the origins of multicellular life.

• evaluate the contributions ediacaran and trilobite fossils have made to our understanding of animal evolution.

• Define tetrapods, and discuss their significance to human evolution.

Mechanisms of Evolution

• Compare and contrast the factors leading to directional and stabilizing selection.

• Discuss the outcomes of directional and stabilizing selection.

• Discuss the influence on gene flow of geographic and reproductive isolating barriers.

• compare and contrast allopatric, parapatric, and sympatric speciation.

• explain how isolating barriers contribute to varying models of speciation.

Natural Selection

• Compare and contrast the factors leading to directional and stabilizing selection.

• Discuss the outcomes of directional and stabilizing selection.

• Explain how predators can act as agents of selection.

• Explain how selection can vary across a species' range.

• Explain how natural selection can act on an extended phenotype.

• Analyze the role of natural experiments in our understanding of evolutionary change in response to selection.

• Explain how selective sweeps can be detected within genomes.

• Evaluate the evidence for the role of humans as selective agents in the evolution of plants and animals.

Species and Speciation

• compare and contrast the phylogenetic, biological, and general lineage species concepts.

• Discuss the influence on gene flow of geographic and reproductive isolating barriers.

• compare and contrast allopatric, parapatric, and sympatric speciation.

• explain how isolating barriers contribute to varying models of speciation.

• List the types of evidence scientists use to evaluate different models of speciation.

• Discuss the challenges of studying speciation.

• explain why the rate of speciation may vary among organisms.

• Describe the significance of the discovery of an example of a cryptic species.

• Discuss the challenges of applying species concepts to bacteria and archaea.

Phylogeny

• construct a simple phylogeny and identify the different components.

• explain how different lines of evidence can lead to different conclusions about species' taxonomical relationships.

• Discuss how scientists can determine the timing of branching events.

• explain how phylogenies can be used to develop hypotheses about the evolution of tetrapods.

• explain how the bones of the middle ear can be used to trace the evolution of mammals.

Describe the methods scientists use to construct phylogenetic trees.

• Discuss the kinds of evidence used to determine the origin of tetrapods, humans, and hiV.

• Discuss how the neutral theory of evolution is used to deduce the timing of evolutionary events and the history of natural selection.

• explain how phylogenetic approaches can assist researchers in identifying disease- causing genes.

Molecular Evolution (DNA)

• Compare and contrast DNA regulation in eukaryotes and in bacteria and archaea.

• Map the events that occur during transcription and translation.

• Discuss mechanisms that influence gene expression.

• Explain the function of coding and noncoding segments of DNA.

• Differentiate between somatic mutations and germline mutations and their roles in variation within a population.

• Explain the roles that independent assortment and genetic recombination play in evolution.

• Discuss vertical and horizontal gene transfer.

• Discuss the complex relationship between genotypes and phenotypes.

• Explain the role of the environment in gene expression.

• Discuss how an organism's genome reflects its evolutionary history.

• Explain why the link between the genotype and phenotypic traits is far more complicated than the genetic polymorphisms that Mendel studied.

Molecular Evolution (Proteins)

• compare and contrast homology, convergent evolution, and parallel evolution.

• Name three examples of convergent evolution.

• name two examples in which proteins with a given function were co- opted for other functions.

• explain how mutations to regulatory networks affect development of an organism.

• explain how novel traits can arise when existing genes are expressed in new contexts.

Macro- and Micro-Evolution

• compare and contrast the processes involved in macroevolution and microevolution.

• compare and contrast the patterns that result from macroevolution and microevolution.

• evaluate the effects on total species diversity when origination and extinction rates vary.

• list the kinds of evidence needed to distinguish between dispersal events and vicariance events in the fossil record.

• Describe how paleontologists analyze the fossil record to reconstruct macroevolutionary patterns.

• explain what kinds of opportunities can give rise to adaptive radiations.

• Distinguish between background extinctions and mass extinctions.

• Describe two abiotic factors potentially responsible for mass extinctions.

• evaluate the evidence for human influence on biotic and abiotic factors affecting biodiversity.

• Discuss whether human influence on biotic and abiotic factors may lead to another mass extinction.

Coevolution

• explain how coevolution is driven by natural selection.

• explain the process of reciprocal selection in terms of the geographic mosaic theory of coevolution.

• compare and contrast the outcomes of coevolution when antagonistic relationships are between two species versus among many species.

• Differentiate between negative and positive frequency- dependent selection and how they function in coevolutionary relationships.

• compare and contrast the coevolution dynamics of müllerian and Batesian mimicry.

• explain how coevolution can promote diversification.

• Describe an example of endosymbiosis.

• explain how parasites affect the fitness of their hosts and vice versa.

Human Evolution

• Describe Darwin's evidence for classifying humans as primates, and contrast this evidence with the more recent data that scientists now use.

• explain the major splits in the primate lineage.

• Discuss two hypotheses for the evolution of bipedalism.

• explain how living primates can help us understand fossil hominins.

• Discuss the importance of toolmaking in the evolution of humans.

• compare and contrast the anatomy of australopithecines and Homo.

• explain the scientific de bate about the placement of Homo naledi in the human lineage.

• compare and contrast Homo neanderthalensis and Homo sapiens.

• explain how DNA can be used to examine the relationship between Neanderthals and modern humans.

• Describe some of the selective pressures that led to the evolution of the human brain.

• explain the different ways in which scientists can study the evolution of language. • explain how selection is currently acting on human maternity.

• Discuss the homologies between humans and other mammals that underlie our emotions.

Sexual selection

• Describe the mechanisms leading to sexual selection.

• Explain why males are competitive among them and females are choosy .

•Describe ways in which sexual selection can benefit extreme traits mainly in males.

• Compare and contrast various types of female preferences.

•Describe the concepts of direct, indirect and sensory biased selection.

•Explain the mechanism of run away selection.

• Explain the handicap theory.

Adaptation theory

• Describe the concept of adaptation and explain the experimental and theoretical approaches used to establish the adaptational value of a trait.

•Explain the concept of trade – offs among parameters of adaptation.

• Explain the aging mechanisms of antagonistic pleiotropism and mutational load.

•Explain the concept of evolutionary stable strategy.

Kin selection. Altruism evolution

•Explain the concepts of Kin selection and receprocality.

•Describe the concept of extended phenotype and its contribution to altruism evolution.

•Explain the concept of parental investment and its connection to conflict between parents and offsprings.

•Explain the application of Hamilton's rule on symbiotic relationship cases.

Group selection

•Explain the mechanism of group selection.

•Connect group selection with shifting balance theory.

•Explain the conflict between group and individual selection and define the end point balance in different population and evolutionary scenarios.