Running Lecture Outline: [BIO - 131]

[Zachary Rich]

Academic Year 2019-2020

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1 January, 2020

1.1 Tues, Jan 28th: Intro to Organisms II: Defining Organisms

- Living Organisms have 3 requirements
  - Made up of one or more cells
    - All organisms are made up of cells that are surrounded by a cell/plasma membrane
    - Unicellular (aka single-celled) organisms are composed of only one cell
      - Easy and quick to reproduce and have Low energy requirements
    - Multicellular organisms are composed of many cells connected together
      - Larger body size, Specialized tissues and body parts, More control over body processes and position in environment.
  - Made up of Genetic Material
    - DNA!
      - DNA contains genetic information
      - Gene are the segments of DNA that contain instructions to make a specific protein
      - Proteins influence the functions and physical characteristics of organisms.
    - Prokaryotes Vs. Eukaryotes
      - Protists, Plants, Animals, and Fungi are Eukaryotes: DNA is contained in a nucleus inside the cell membrane
      - Bacteria and Archaea are Prokaryotes: DNA is free-floating inside the cell membrane
  - The ability to gather materials and harness energy from the environment

    * Photoautotrophs
        · Use energy from the sun to make own food
        · Bacteria, Protists, Plantae
    * Heterotrophs
        · Consume other autotrophs or heterotrophs to use as food
        · Bacteria, Archaea, Fungi, Protists, Animals
    * Chemoautotrophs
        · Use energy from chemicals in the environment to make own food
        · Bacteria, Archaea

- 6 Major Groups of Organisms
    - ***Animals***
        * MultiCellular only
        * Eukaryotes only
        * Hetero-
    - ***Plants***
        * MultiCellular only
        * Eukaryotes only
        * Photoauto-
    - ***Fungi***
        * Multicellular and Unicellular
        * Eukaryotes only
        * Hetero-
    - ***Bacteria***
        * Unicellularr only
        * Prokaryotes only
        * Hetero-, Photoauto, Chemoauto-
    - ***Archaea***
        * Unicellular only
        * Prokaryotes only
        * Hetero-, Chemoauto-
    - ***Protists***
        * Both Multicellular and Unicellular
        * Eukaryotes only
        * Hetero-, Photoauto-

1.2 Thur, Jan 30th: Organismal Origins

Definition 1. *Proto-Cells: A Collection of lipids, A stepping stone to the origin of life.*

Definition 2. *Biomolecules*

Definition 3. *Evolutionary Theory: Describes change in living things over time. It explains the historical trajectory of individual groups of organisms. It also explains relatedness among diverse groups of organisms.*

Definition 4. *Domain Bacteria*

Definition 5. *Domain Archaea*

Definition 6. *Domain Eukarya*

Definition 7. *Common Ancestor*

Definition 8. *Deep-sea Hydrothermal Vents: Geysers spewing hot water (760F!) full of nutrients and minerals, discovered in 1970's.*

Definition 9. *Tube worms and trophosomes: A worms 'Gut'. It helped deal with the worms nutrients*

Definition 10. *Cyanobacteria*

Definition 11. *Oxygenic Photosynthesis*

Definition 12. *Mitochondria*

Definition 13. *Aerobic Bacteria*

Definition 14. *Cellular Respiration*

Definition 15. *Chloroplasts*

Definition 16. *Endosymbiotic Theory*

- *How do you go from a bunch of non-living chemicals floating around to the first living organism?*
- *Proto-cells formed that contained 3 functional biomolecules surrounded by lipid membrane.*
  - *Carbohydrates: Used for energy and structure.*
  - *Proteins: Used for structure and cell functions (e.g. enzymes, transport, defense, communication).*
  - *Nucleic Acids: Hold genetic instructions for making proteins*
- *Proto-cells self replicate and slight changes occur each time.*
- *Repeated 'Descent with Modification' took us from the first living organism to the huge diversity of organisms on earth.*
- *The 3 domains of life, Bacteria, Archaea, and Eukarya are all united by a single Common Ancestor*
- *Scientists hypothesize that the first living organisms were Chemoautotroph prokaryotes in deep-sea hydrothermal vents*
  - *Early prokaryotes were likely chemoautotrophs because they lived in deep dark water and had no access to sunlight.*
- *1.5 billion years after the first prokaryotes arose, the first photoautotroph prokaryotes evolved: Cyanobacteria!*
- *Eukaryotic organisms arose after bacteria and archaea.*
- *Eukaryotic cells are more complex than prokaryotic cells.*
  - *DNA in Nucleus: centralized DNA for more control over protein production.*
  - *Mitochondria: Make ATP energy.*
  - *Chloroplasts: make food (photoautotrophs only)*
- *Chloroplasts allow some eukaryotes to use sunlight to make food by performing oxygenic photosynthesis.*
- *Mitochondria allows all eukaryotes to use food to make ATP energy through the process of cellular respiration.*
- *How did eukaryotes get mitochondria? Through endosymbiosis of aerobic bacteria! The large prokaryote eats the small prokaryote.*
- *How did eukaryotes get chloroplasts? Through the endosymbiosis of cyanobacteria!*
- *Evidence supports endosymbiotic theory that mitochondria and chloroplasts were once free-living bacteria:*
  - *They have their owm DNA and make their own proteins*
  - *They are genetically more closely related to free-living bacteria (that werent engulfed) than to their eukaryote hosts*
  - *They have double cell membranes (one from being single celled organisms and another formed when engulfed.*
  - *They reproduce independently of the eukaryotic cell.*

2 Febuary, 2020

2.1 Tues, Feb 3rd: Evolutionary Patterns I

Definition 17. *Phylogeny: "family tree" that shows the evolutionary relationship among organisms*

Definition 18. *Morphology: The branch of biology that deals with the form of living organisms, and with relationships between their structures.*

Definition 19. *Molecular data (DNA): Molecular data can usually be described as a sequence of letters using a 4-letter code. This lends itself to very formalized descriptions of sequences.*

Definition 20. *Universal Genetic Code: The universal genetic code is a common language for almost all organisms to translate nucleotide sequences of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) to amino acid sequences of proteins. However, the genetic code is still evolved.*

Definition 21. *Common Ancestor: The parent node of a set of nodes.*

Definition 22. *Node: A splitting point in a tree.*

Definition 23. *Root: The common ancestor lineage for all branches that follow from it.*

Definition 24. *Lineage (branch): Each branch shows the lineage of an organism or group. A sequence of species each of which is considered to have evolved from its predecessor.*

Definition 25. *Divergence (Split): This shows the divergence from a common ancestor, which leads to new branches.*

Definition 26. *Shared Ancestry: The Nodes and Branches traveled by you and other groups*

Definition 27. *Unique Ancestry: Branches only traveled by your group*

Definition 28. *Relatedness: How similar the DNA is.*

Definition 29. *Sister Group: Groups that are more closely related to each other than any other group*

- *Examine what DNA sequences are Common across very different species to see common ancestry.*
- *Examine what DNA sequences are unique between closely-related species to determine when species diverged/separated*
- *Examine how different DNA sequences within individuals of the same species relate to disease & other traits*
- *Phylogenetic trees tell us a LOT of information about the history and relatedness of taxa (groupings of organisms, e.g. species, genus)*
  - *Speciation Events*
    - *Speciation events are shown as nodes on the phylogenic tree.*
  - *Timescale: past to present*
    - *Moving from root to branch tips*
    - *The order of nodes from past to present indicate the sequence of speciation events in time*
    - *The tips of the branches represent present day organisms*
  - *Shared and Unique Ancestry*
    - *Shared Ancestry: The Nodes and Branches traveled by you and other groups*
    - *Unique Ancestry: Branches only traveled by your group*
  - *Degree of Relatedness*
    - *Groups are more closely related to each other if they share a more recent common ancestor (node)*

2.2 Tues, Feb 18th: Evolutionary Patterns II

2.3 Mechanisms of Evolution I

Definition 30. *Allele: An alternate version of a single gene*

- *DNA is a collection of genes*
- *Each gene is a sequence of DNA that codes for a specific protein*
- *Alleles are alternative versions of genes*
  - *A change in a DNA base in a gene can give rise to a new allele that can code for a different protein and a different version of the trait that is controlled by that gene.*
  - *New alleles arise in individuals by random mutation*
    - *Mutations are changes in the DNA bases that produce new alleles in an individual.*
      - *Random and Occur all the time*
      - *Can be beneficial, harmful, or most often neutral*
    - *If the new mutation occurs in a sperm or egg cell, the new allele can be passed onto offspring and spread through the population over generations, leading to genetic variability in the population*
- *Genotype is the combination of alleles that an organism has for a given gene*
  - *Many organisms have two copies of each gene (1 copy from sperm + 1 copy from egg during fertilization)*
- *Phenotype is the physical trait that is coded by the genotype*
- *Calculating the allele frequency in a population:*
  - *Step 1: Determine the different alleles that are present for the gene of interest*
    - 2 *alleles,* A *and* a
  - *Step 2: Determine the total number of alleles in the population*
    - *Total alleles* : 18
  - *Step 3: Determine the proportion of each allele type compared to the total number of alleles in the population*
    - $A : \frac{13}{18} = 0.72$
    - $a : \frac{5}{18} = 0.28$

2.4 Mechanisms of Evolution II

3 March, 2020

4 April, 2020

5 May, 2020