

Evolutionary Biology Final Review Fall 2011

Monday, December 05, 2011 10:29 PM

Is a Giraffe Neck Long or Short?

- Hyp1- Foraging Behavior (eating from higher leaves/ trees)
- Hyp2- Aggressive Behavior (the male giraffes would fight one another very roughly and it was seen as a mating display)
- Hyp3- Longer Legs
 - Giraffes are herbivores
 - Main mechanism of escape is most likely running
 - Longer legs= greater speed
 - Long legs= difficult to get water (critical)
- NO SINGLE SOLITARY HABITAT THAT CAN CHANGE AN ANIMAL TOTAL ACTIONS AND GENETIC MAKEUP
- These hypothesis are somewhat obscure because the giraffes are being analyzed from only one standpoint and they do not explain why other animals don't have long necks to compensate for the competition with plants and resources

Biological Systems are not linear, it has a cycle/ rhythm
Biological systems have a positive and negative feedback

Evolution as a hypothesis

- Evolution- organisms change through time
 - Species are not fixed
- Historical Development of the Hypothesis
1. Linnaeus- classification scheme(binomial nomenclature)
 2. Hutton- proposes a system of gradualism geological formations have different layers created at different times
 - Earth was considerably older than religious beliefs
 3. Adam Smith- Laissez Faire economics (hands off) let the system do as it shall
 4. Lamarck- system of acquired characteristics
 5. Malthus- population grows geometrically
 - Resources decreases population will crash
 6. Lyell- wrote the defining tome on the synthesis of geological thought (how different layers were produced)
 - Studied fossils and realized you see things within a time period
 7. Cuvier- conveyor of studies in paleontology
 8. Darwin- Natural Selection as a mechanism of change
 9. Wallace- co- founder of Natural Selection
 - Published articles w/o sure verification
 10. Mendel- origin of genetic relationships

Evidence from Embryology

- Law of Development (Von Baer)
- General Traits appear first, before more complex traits
- Specific traits appear later
- Developments of all vertebrates are similar
- **Biogenic Law**- Ontogeny recapitulates Phylogeny - Individual development repeats evolutionary history

Evidence from Comparative Anatomy

- Vertebrate Morphological studies
 - Fore limbs Bauplan -Basic anatomical plan(body plan)
 - Heart
 - Gills and Lungs

Evidence from Organ Systems - Respiration

- Fish- gills
- Amphibian- Gills, Simple Lungs
- Reptile- Complex Lung (4 chambers 2 atria, 2 ventricles)
- Birds and Mammals- Very complex lungs
 - Birds have the best lungs

Homology- Teeth, bones of the skull (similar structure from common ancestors)

Homoplasy- similar function but not derived from common ancestor

Vestigial Organs- structures w/ no apparent function or whose function differs from that of its ancestors

- Ex: Human appendix, human tail bone, wings in flightless birds, hind limbs bones of a whale

Hypothesis for Natural Selection

- Evolution occurs by process of natural selection given the assumptions
 - Individuals Vary
 - Variations are inherited
 - Populations tend to over breed
 - Struggle for existence
 - Survival of the fittest
 - New Species Develop

Why do imperfections exist in the fossil record?

1. Most organism don't fossilize → soft tissues and stable environment
 2. Fossils destroyed by erosion and geological disturbances
 3. Most fossils are inaccessible
 4. Fossils are hard to find
- Links are undefined phenomena imply distinct or unit connections.
- Transition Species
- More important concepts
 - May not be intermediate in structure or time
 - or relationship maybe a branch point where ancestors in transition range

Evidence from Cell Theory

Microscopic structure of organisms shows evidence of common ancestry
1974-1916 Van Leeuwenhook- discovered microorganisms
1839 Scheiden- Plants made of cells
1839 Schelliden Animals are all made of cells
1859-Vichrow All cells come from other cells
Cells are the basic unit of life.

Evidence From Genetics

- 1) Chromosomes found in nuclei
- 2) Numbers of chromosomes varies among species
- 3) Chromosomes come in pairs(ALL EUKAROTIC ORGANISMS)
- 4) Diploid=2n Haploid=n
- 5) Polyploidy multiple copies
- 6) Mendel's Factor's genes are located along chromosomes.
- 7) Many genes exist on each chromosome
- 8) Genes are composed of DNA, RNA, Protein.

Eukaryotes

Internal membrane- Golgi apparatus, vacuoles, nuclear membrane
Mitochondria and chloroplasts
9+2 flagella and cilia
Many chromosomes

Prokaryotes

Have nucleus
Have multiple chromosomes
Use DNA as a genetic material
Are photosynthetic (not all cells only plant cells)

Mutations I

Abrupt changes in the species in the genetic material occurring typically during cell division in gametes

- Changes in the autosomal (non sex cells) are irrelevant
- Only changes in the gametes are considered a mutation
 - Types of Mutations
 - i. Structural changes in Chromosomes
 - 1) Loss or Duplication of whole genes
 - a) Deletions
 - b) Duplications
 - c) A movement in the genetic form from one chromosome to another
 - ii. Changes in gene arrangement
 - Transposition
 - Internally generates fragments
 - Transposed elements are replicated and can be relocated to other regions of same/ different chromosomes. ^ increases variability
 - Numerical Changes in Chromosomes
 - **Aneuploidy**- addition of one or more chromosomes
 - Down's syndrome- extra chromosome #21 (trisomic)
 - Extra Sex Hormones- $xy,xyy, xxyy,xyxy$
 - **Polyploidy**- Multiple copies of the entire genome
 - Characteristic of several plant species.
 - Gene Point Mutations- changes in the bases of the DNA or at a single base (Nucleotide changes (A C T G))
 - Substitutions
 - Addition
 - Subtraction
 - Causes of Mutations
 - i. Chemical mutagens
 - ii. Spontaneous Mutations during DNA replication
 - iii. Corrections that are not fixed by DNA polymerase(building back DNA that have been separated)
 - Mutator Genes
 - Can control the mutation rate
 - Greater change in base over time
 - Effect of Mutations
 - 1) Harmful/ lethal
 - 2) Minor/ Major
 - 3) Produces a protein
 - 4) Most Mutations are recessive.
 - i. If the genes are recessive it would make it more difficult for the gene to be seen in the phenotypic form but will still be passed to the offspring which could still cause complications within the body.

Mutation II

Silent Mutations- mutations for quick codon change in amino acid
Mutated gene- expressed that some fitness within the environment

Beneficial- Increases fitness if an organism

Protein Chain Length Modifiers- Start and Stop Codons- tells the RNA polymerase when to begin process and when to end

Mutations in developmental genes

- genes regulate rate and cues in developing organisms
 - **Heterochronic Mutations**- alter the rate of some organs relative to the others in the organism
 - **Paedomorphic**- shifts the rate of development between germ line and the somatic cells (changes the rate of development)
 - **Neotony**- an example where the germ line developmentally speeds up with respect to the somatic cells, producing sexually precocious(blossoming early, before maturation) organism
 - **Allometry**- morphological measurement comparing growth rates between tissues or structure.
- Shifts in growth gradients
 - Transformation of species by genetic changes in embryonic gradients
 - Growth rate not only effects the skeleton but can increase the size of the eyes among other features.
- Homeotic mutations
 - Regulate clusters of genes controlling development
 - Hom.Hox- only effect is in the nucleus
 - Any organism that has symmetry will have this these developmental genes.
 - If you can change the sequence you can change the appendage and can change symmetry of an organism.
 - Hox genes nearer the 5' end are active earlier in development
 - Homeobox - 180 nucleotides
 - Identical in all homeotic genes and produce identical 60 amino acids sequences in signaling protein sites on DNA.

Evo. Biology Final Review Part 2

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Evolution occurs by:

1. Acquired Characteristics
2. Natural Selection
3. Mutation

Today's View

- Mutation provides variability - New alleles
- Sexual and genetic recombination by reshuffling existing alleles
- Survival of the fittest- organism that can efficiently reproduce will survive and continue their species

Gene Locus

- Chalmitid- causes a change in developmental cues
- Gene locus is a generally specified location for a given gene on a given chromosome

Gene Linkage

- Genes located on the same chromosome
- They DO NOT SORT INDEPENDENTLY

Crossing Over

- Sister chromosomes can exchange whole sections of a chromosome
- Leads to genetic recombination
- Increases Variability

Concept of Multiple Alleles

- One type of blood group has 3 alleles, which gives rise to 6 possible genotypes (MAX 2)

Pleiotropy

- Multiple effects of a single gene in different organ
- Different functioning protein in different organs
- Ex: Cystic Fibrosis
 - Controls the amount of chloride which combines with mucous to filter the oxygen
- When you use your muscles, you provide lactic acid which causes sore muscles.

Polygene Inheritance

- Traits determined by several genes at different loci
- Ex: Heights in Humans

Incomplete Dominance

- Heterozygous are intermediates, Differential expression.

Co- Dominance

- Both alleles expressed equally Ex: Sickle Cell Anemia
- Change in one amino acid in one chain of hemoglobin

Natural Selection

- 1) Differential variability- Darwin's major mechanism
 - 2) Differential reproduction(non random breeding)- leads to differences in the proportion of alleles passing to next generation
- What produce selection?
- Internal Environment- genetic makeup
 - **Genome**- genetic makeup of the organism controlling factor for protein synthesis
 - External Environment-
 - Physical/biotic environment
 - Floods, volcanoes, pH, changes in the concentration of ions
 - Biological Environment
 - Competition
 - Predation
 - Parasitism
 - **Effectiveness of Selection**
 - **Artificial Selection**
 - Directed selection of specific traits
 - Dogs
 - Farm Animals (egg production)
 - Farm crops (wild cabbage)
 - **Natural Selection Examples**
 - Lizards- habitat Selection- Depending on where they live, decide the type of leaf they will obtain

Evidence from Biochemistry

1. Central Dogma of Molecular Biology

★ **DNA → RNA → proteins**

- Need Cell and Cell Membrane

Protein Analyses

- Sequences of amino acids
- Linear
- Bound by peptide bonds
 - Genes are composed of DNA
 - Phosphate bonds outside the helix
 - Hydrogen bonds connect the different nucleotides

A) Immunological Techniques

- 1st way to compare proteins to see relation of organisms

B) Amino Acid Techniques

- # and distribution of amino acids residues
- See the function of amino acids and check to see if it serving the same purpose in another organism

Restriction Enzymes

- Methodology to recognize short nucleotides sequences and to break double stranded DNA
- Producing RFLP's = Restriction Fragment Length Polymorphisms
 - Separated by electrophoresis

C) Nucleotide Sequencing

- 1) Compare protein coding regions or non coding regions
- 2) Complete sequences for a number of organisms

- a. Little amount of prokaryote DNA is non-coding whereas 95% of human is non-coding

D) Polymerase Chain Reaction

- a. Most powerful technique for identifying DNA sequences
- b. By increasing- decreasing temp can break hydrogen bonds rather quickly
- c. Expanded the efforts of the human genome project
- d. Increases the # of duplicate fragments of DNA

Population Genetics

- Study of change in gene frequency in the population through time Gene Pool
 - Number of alleles present in the population
- ! **Gene Frequency and Genotype frequency remain constant in the population if:**
- Random Breeding
 - No Differential migration (same geographical area)
 - Large Population
 - No mutation
 - No natural selection

With these conditions, distribution of alleles can be explained through :

- $p^2 + 2pq + q^2 = 1$
- Hardy Weinberg Principle = describes static and No Evolution

Genetic Drift

- In small population, random events in breeding and mortality, leading to variations in allele frequency (random selection)
 - Losing an allele in a small population has a greater effect than one that occurs in a large population
- ### Evolution in small population
- Islands
 - Founding new colonies " founder Principle"
 - Population crashes, when resources are depleted (huge mortality, can lose alleles

Neutralist vs Selectionist Theory

- a) **Selectionist Theory**- most molecular changes due to random fixation acting on advantageous mutants
- b) **Neutralist Theory**- most molecular changes due to random fixation of