Honors Biology
Ch 16 Population Genetics
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EVOLUTION
(Population Genetics)

--- the frequency of an allele in a gene pool depends on many factors and may be STABLE or UNSTABLE over time

*****NATURAL SELECTION ACTS ON THE PHENOTYPE RATHER THAN THE GENOTYPE OF AN ORGANISM**

--- Natural selection works directly on the expression or appearance of an inherited trait(the PHENOTYPE) rather than on the gene combination that produces the trait(the GENOTYPE)

--- the influence of a dominant allele for a trait over a recessive one in the genotype determines the resulting PHENOTYPE-- on which NATURAL SELECTION ACTS!!

***** Alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool(an example would be sickle-cell anemia)**

***** 2 types of allele pairings can occur in the genotype:**
1) **HOMOZYGOUS- pairing two of the SAME alleles, whether dominant or recessive**
2) **HETEROZYGOUS- pairing of two DIFFERENT alleles**

>>>> RECESSIVE LETHAL ALLELES(i.e. Tay Sachs disease) will cause the death of ONLY the homozygous recessive individual

*****Healthy heterozygous individuals will be able to contribute the "masked" recessive gene to the population's GENE POOL, thus allowing the gene to persist**

MUTATIONS

*****New Mutations are CONSTANTLY being generated in a gene pool(random,environmental, etc)**

>>>> Mutation is an important source of GENETIC VARIATION within a gene pool

>>>> the RANDOM changes take the form of ADDITIONS, DELETIONS, and SUBSTITUTIONS of nucleotides and of REARRANGEMENTS of CHROMOSOMES (GENE MUTATIONS AND CHROMOSOMAL MUTATIONS)

***** the effect of many mutations is minor and neutral, being neither favorable nor unfavorable to survival and reproduction**

***** other mutations may be BENEFICIAL OR HARMFUL**

>>>> Genetic diseases or unwanted traits cannot be eliminated from a population through "culling" or selective breeding because new, spontaneous mutations constantly re-appear

VARIATION

***** VARIATION WITHIN A SPECIES INCREASES THE LIKLHOOD THAT AT LEAST SOME MEMBERS OF A SPECIES WILL SURVIVE UNDER CHANGED ENVIRONMENTAL CONDITIONS**

--- as environmental factors change, natural selection of ADAPTIVE TAITS must also be re-aligned

***Variation within a species stemming either from mutation or from genetic recombination BROADENS the OPPORTUNITY for that species to ADAPT to CHANGE. Increasing the PROBABILITY that at least *some* members of the species will be suitably adapted to the new conditions

*** GENETIC DIVERSITY promotes survival of a species should the environment change significantly

"SAMENESS" would mean VULNERABILITY and that could lead to EXTINCTION!!!!!

SPECIATION

- Evolution is the result of genetic changes that occur in constantly CHANGING ENVIRONMENTS

- NATURAL SELECTION determines the "DIFFERENTIAL SURVIVAL" of groups of organisms

*** Genetic changes can result from:
1) Gene recombination during gamete formation
2) Mutations

*** these events are responsible for VARIETY and DIVERSITY within each species

*** Natural selection favors the organisms that are better suited to survive in a given environment

*** those not well suited to the environment may DIE before they can pass on their traits to the next generation

*** as the ENVIRONMENT changes, selection for Adaptive Traits is re-aligned with the change → Traits that were *once* adaptive may become disadvantageous

*** a GREAT DIVERSITY of species increases the chance that at least some organisms will survive major changes in the environment

*** this is similar to the idea that diversity *within* a species is important in surviving changes in the environment

*** for the same reasons pertinent to those for *intra*species diversity, increased diversity among species increases the chances that *some* species will adapt to survive future environmental changes

GENETIC DRIFT

***if, a random sample of individuals is separated from a larger population, the GENE FREQUENCIES in the sample may *differ* significantly from those in the population as a whole

*** the SHIFTS in frequency depend only on which indivuals happen to fall in the sample (it is RANDOM!)

--- because a RANDOM shift in gene frequency is NOT *guaranteed* to make the next generation better adapted, the shift-- called here GENETIC DRIFT --- is not necessarily an ADAPTIVE change

--- 2 examples of situations that can lead to Genetic Drift in small populations:

1) BOTTLENECK EFFECT:
-- non-selective population reductions due to disasters
-- i.e. suppose only 3 of 37 "clans" survive a volcanic eruption on a tropical island-- one of those surviving clans had high frequencies of albinism; albinism will then be at higher levels in the new population

2) FOUNDER EFFECT:
--- the colonization of a new habitat by a few individuals
--- Pitcairn Island and the mutiny on the Bounty is a good example

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REPRODUCTIVE AND GEOGRAPHIC ISOLATION AFFECTS SPECIATION

1) REPRODUCTIVE ISOLATION:
--- *Events that lead to reproductive isolation of populations of the same species cause new species to appear*

--- barriers to reproduction that prevent mating between populations are called PRE-ZYGOTIC(*before fertilization*) if they involve such factors as:

1) the isolation of habitats
2) a difference in breeding season

3) a difference in mating behavior
4) an incompatibility of reproductive organs or gametes

--- POST-ZYGOTIC(*after* fertilization) barriers that prevent the development of viable fertile hybrids exist because of:
1) genetic incompatibility between populations
2) hybrid *sterility*
3) hybrid breakdown

2) GEOGRAPHIC ISOLATION:

A) Sympatric Speciation:
- isolation events that occur within the geographic range of a parent population

B) Allopatric Speciation:
- the geographic isolation of a small population from its parent population

*** sympatric speciation is much more common in plants than animals

--- due often to POLYPLOIDY(extra sets of chromosomes) which results from *mistakes in plant cell division* --but they are still able to reproduce----THIS CAN LEAD TO SPECIATION

*** ALLOPATRIC SPECIATION occurs in animal evolution when geographically isolated populations *ADAPT* to different environmental conditions
--- the *rate* of allopatric speciation is faster in small populations than in large ones because of greater ~~Gentic~~ Genetic Drift

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WHAT THE FOSSIL RECORD SHOWS ABOUT EVOLUTION:

***** analysis of the fossil record reveals the story of major events in the history of life on earth(MACRO-EVOLUTION) (*Micro*-evolution is the small changes in genes and chromosomes that occur within a single population)**

***** explosive radiations of Life following MASS EXTINCTIONS mark the 4 Eras of the GEOLOGIC TIME SCALE:**

1) Precambrian- 4.6 bya to 544 mya
2) Paleozoic - 544- 245 mya
3) Mesozoic- 245-65 mya
4) Cenozoic- 65 mya to present

--- the study of biological diversity from the fossil record is generally limited to the study of the differences *among* species instead of the differences within a species

-- BIOLOGICAL DIVERSITY *within* a species is difficult to study because preserved organic material is rare as a source of DNA in fossils

***** the appearance of novel characteristics(like wings or feathers) or a mass extinction(that has cleared the way for a new species to inhabit recently vacated adaptive zones) can lead to EPISODES OF SPECIATION**

***** EXTINCTION IS INEVITABLE IN A CHANGING(EVOLVING) WORLD**

***** EXTINCTIONS USUALLY COINCIDE WITH RAPID GLOBAL ENVIRONMENTAL CHANGES**