Biology 30 IB
Populations

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Unfinished!

Contents

- Most species have thousands of genes
- More genes = more genetic diversity
- More alleles in said genes = more genetic variation
- Genetic diversity increases from sexual reproduction

Human Populations

Problems with Human Genes

- Few offspring
- Observations take time
- Many traits affected by environment as well as genes

Population Sampling

- Technique used to study human populations
- **Representative group** = group within population is selected, not entire population
- **Trends** or **Frequencies** = how often genes occur in the representative group
- **Gene pool**, aka. **genome** = all genes in a population
- **Fixed frequency** = only 1 allele for a gene, all organisms in population has gene

Frequency

- **Genotype frequency** = proportion of a population with a particular genotype (expressed as a decimal)
- **Phenotype frequency** = proportion of a population with a particular phenotype (expressed as a decimal or %)
- **Allele frequency** = rate of occurrence of a particular allele in a population with respect to a particular gene (expressed as a decimal)

Hardy Weinberg Principle

- Populations have either a...
  - tendency to remain stable
  - tendency toward variability
- **Genetic equilibrium** = if all other factors remain constant, the gene pool will have the same composition generation after generation
- Population evolve when equilibrium is upset

Hardy Weinberg Equilibrium

1. $$p + q = 1$$
   - Allele frequency
   - p = frequency of dominant allele (e.g. A)
   - q = frequency of recessive allele (e.g. a)

2. $$p^2 + 2pq + q^2 = 1$$
   - Genotypic frequency
   - Above formula, but for all heterozygote father and heterozygote mother crosses

Tips

- A = p, a = q
- AA = p^2, Aa & Aa = $2pq$, aa = q^2
- Work with homozygous recessive individuals first
  (only one possible genotype — homozygous recessive)

Conditions of No Evolution

Conditions under which no change will occur in a gene pool are...

- Large populations = changes in gene frequencies are not the result of random chance alone
- Random mating
- No mutations
- No migration = no immigration, no emmigration, no new genes enter or leave the population
- Equal viability (no disease), fertility, and mating ability of all genotypes (no selection advantage)

(21.2) Conditions of Evolution

The population gene pool is very unstable.

Conditions under which change will occur in a gene pool are...

- **Mutation**
  - Changes in the genetic makeup, either chromosome mutation or gene mutation
  - Occurs during meiosis
  - May be harmful in some parts and beneficial others
    e.g. sickle cell anemia carriers (heterozygous) have malaria resistance
- **Migration** (aka. Gene Flow)
  - Movement of members of a species, into (immigration) or out of (emigation) a population
  - **Immigration** = new genes are added to existing gene pool
  - **Emigation** = genes are removed
- **Non-random Mating** (aka. Sexual Selection)
  - Choice of which males will mate with which females
  - Choice often made by woman, based on physical or behavioral traits of mate
  - **Sexual dimorphism** = difference between male and female phenotypes (e.g. mane, antlers)
- **Small Populations**
  - **(Random) Genetic Drift**
    - Disruption of genetic equilibrium in small populations
    - If a unique allele does not mate, the allele is gone forever
  - **Founder Effect**
    - Few individuals of large population leave, forms new population
    - Allele frequencies will not be the same as former population
  - **Bottleneck Effect**
    - Severe environmental event, drastic reduction in population size
    - Allele frequencies very different than original population
  - **Natural Selection**
    - Only process that leads directly to evolution
    - Individuals with greater survival traits reproduce, passing on their favorable genes to the next generation

Mitochondrial DNA & Evolution

- **mtDNA** = Mitochondrion contain their own genetic material
- Mitochondria and chloroplast were once individual organisms, but symbiotic relationship formed with cells
- Mutations in mtDNA = Parkinson's

Speciation

- Process by which species originate
- **Species** = organisms that can...
  - interbreed
  - produce fertile offspring

Geographic Isolation

- Caused by physical obstacles/barriers
- Gene flow between main population and isolated group ceases
- Eventually, new species; become so genetically different that they can no longer interbreed, due to...
  - different adaptations
  - different gene frequencies
  - different mutations

Reproductive Isolation

- Organisms in a population can no longer mate and produce offspring
- Even if barriers are removed
- Even if fertilization occurs, genes so different that zygote doesn't develop
- Due to...
  - differences in mating habits
  - seasonal differences in mating
  - inability of sperm to fertilize eggs

(22.1) Populations & Communities

Characteristics

- **Population** = all individuals, same species, living in the same place, at a certain time
- **Community** = all species that occupy a given area
- **Ecosystem** = all biotic and all abiotic components
- **Geographic range** = map region where sightings of an animal have occurred
- **Habitat** = physical area where an organism lives

Competition

- **Interspecific** = competition between members of different species
- **Intraspecific** = competition between members of same species

Niche

A population's role and contributions in the community.

- Feeding habits
- # of offspring produced
- Prey
- Feces (enrich soil)

Population

Size

- # of the named organisms of the same species
- Location of the population, same habitat
- Time when the #'s were determined

Density

Describes the # of organisms in a defined area.

$$D_p = \frac{N}{S}$$

- D_p = population density
- N = # of organisms counted
- S = space occupied by the population
  (A = land area, V = aquatic volume)

Ecological Density

- Same formula as above
- Area/volume of what the organisms uses (given value)
  Not necessarily area/volume of entire ecosystem

Dispersion

General pattern in which organisms are distributed through a specified area.

- **Clumped dispersion** = grouped in patches or aggregations
- **Random dispersion** = uncommon; no attraction/repulsion among members;
  typically in tropical rainforest — habitat conditions are relatively uniform and plentiful resources, little competition
- **Uniform dispersion** = competition among organisms
  habitat conditions are not uniform and/or plentiful

Chaos Theory

Seemingly random phenomena may have an orderly system/explanation.

(22.2) Changes in Population Size

Terms

- **Natality** = # of offspring of a species born per unit of time
- **Mortality** = # of individuals of a species that die per unit of time
- **Immigration** = # of individuals of a species moving into an existing population
- **Immigration** = # of individuals of a species moving out of an existing population

Change In Population Size

Populations Given

$$\Delta N = P_f - P_i$$

- P_i = population size initially
- P_f = population size at end of study

Populations Not Given

$$\Delta N = (\text{factors that inc. pop.}) - (\text{factors that dec. pop.})$$

$$\Delta N = (n + i) - (m + e)$$

n = natality, i = immigration, m = mortality, e = emigration

Growth Rate

$$gr = \frac{\Delta N}{\Delta t}$$

- ΔN = change in population size
- Δt = change in time

Per Capita Growth Rate

$$cgr = \frac{\Delta N}{N}$$

$$cgr = \frac{P_f - P_i}{P_i}$$