Evolutionary Theory and Biodiversity Cheat Sheet

by ArcelM4 via cheatography.com/198742/cs/42112/

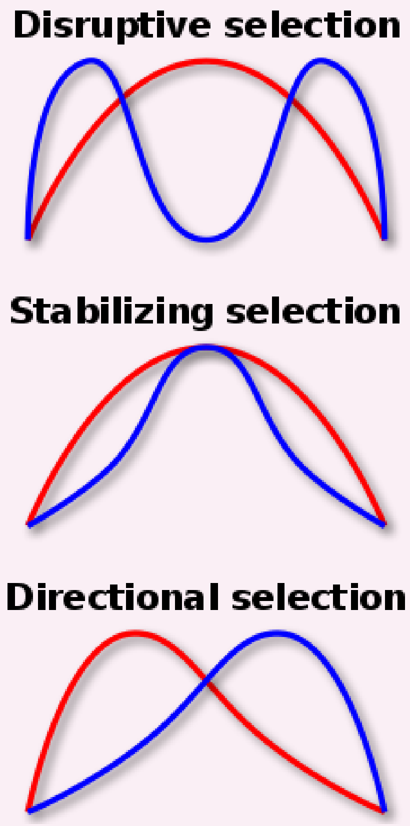
Important People

James Hutton (1726-1792) and Charles Lyell (1797-1875)	Studies uniformitarianism and concluded that Earth is extremely old, changing over time due to natural processes.
Erasmus Darwin (1731-1802)	Suggested that competition between individuals could lead to changes between species.
Jean Baptiste Lamarck (1744--1829)	Proposed a mechanism by which organisms change over time and that living things evolve through the inheritance of acquired characteristics.
Thomas Malthus (1766-1834)	Observed that human populations cannot keep growing indefinitely. If the birth rate was higher than the death rate then all resources would be used up.

Important People (cont)

Charles Darwin (1809--1882)	Formulated a theory of evolution by natural selection based on observations made on his voyage on the HMS Beagle and of selective breeding.
Alfred Russel Wallace (1823--1913)	Proposed a theory of evolution similar to Darwin's and wrote a paper to Darwin to be reviewed, which made him release his theory.

Types of Natural Selection



Red = Before Selection
Blue = After Selection

Microevolution

Microevolution	Describes changes that occur within a population of a single species. It includes the process of natural selection, changes in allele frequencies, and changes in populations that result over time.

Microevolution (cont)

Macroevolution	Describes large-scale and long-term evolutionary patters among many species. The evolution of species from a common ancestor
Processes of Microevolution	Mutation, Natural Selection, Genetic Drift, Gene Flow
Mutation	Changes in the DNA sequence
Natural Selection	Survival of the fittest
Genetic Drift	Shift in the allelic frequencies due to chance. Specifically affects small populations.
Gene Flow	Movement of individuals both in and out of a gene pool.

Populations evolve, not individuals.

The percentage of any specific allele in a gene pool is an allelic frequency and when the frequency stays the same for a long period of time it's called genetic equilibrium.

Two Examples of Genetic Drift

Bottleneck Effect	Results from near extinction of a species.
Founder Effect	Results from a small number of individuals colonizing a new area.

Hardy-Weinberg Principle

The Hardy-Weinberg Principle	A mathematical model that deals with the frequencies of alleles in a gene pool. If the allelic frequency does not change in a population over successive generations, then evolution does not occur and the populations is at an equilibrium.
Condition 1.	No mutations occur so that the gene pool does not change.
Condition 2.	Emigration and immigration do not occur as the would alter the gene pool.
Condition 3.	The population must be large so that changes do not happen by chance alone.
Condition 4.	All mating must be totally random so that one form of allele is not favoured over the other.

Hardy-Weinberg Principle (cont)

Condition 5.	All forms of the allele must be expressed equally well so that there is no natural selection.

It is virtual impossible to meet these conditions, allelic frequencies do change in populations and evolution does occur. This principle also useful in explaining why genotypes within a population tend to remain the same, as well as for determining the frequency of a recessive allele.

Hardy-Weinberg Principle Example 2

While studying a sample of pea plants, you find that 36 of 400 plants were short (recessive). The rest were tall.

q =
p =
q^2 = 36/400
p^2 =
$2pq$ =
↓
q =
p =
q^2 = 0.09
p^2 =
$2pq$ =
↓

Hardy-Weinberg Principle Example 2 (cont)

$q = \sqrt{0.09} = 0.3$
p =
q^2 = 0.09
p^2 =
$2pq$ =
↓
$q = \sqrt{0.09} = 0.3$
p = 1-0.3 = 0.7
q^2 = 0.09
$p^2 = 0.7^2 = 0.49$
$2pq$ = 2(0.7*0.3) = 0.42
↓
0.42+0.49+0.09=1

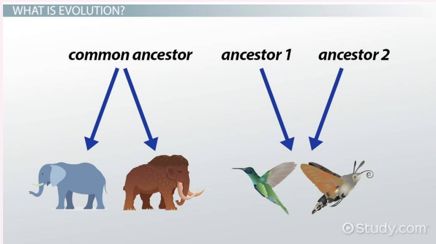
Convergent and Divergent Evolution

Divergent Evolution	The process in which an ancestral species gives rise to a number of new species that are adapted to different environmental conditions.

Convergent and Divergent Evolution (cont)

Homologous Structures	Refers to the structural features with common evolutionary origins. The structure is the same, but the function is different. It is evidence that organisms evolved from a common ancestor.
Convergent Evolution	The process in which different organisms that live in similar distant habitats become more alike in appearance and behaviour.
Analogous Structures	Refers to the evolution of body parts of organisms that do not have a common evolutionary origin but are similar in function. Dolphins and sharks live in the water and both use tails for propulsion, but their tails are from different origins.

Divergent vs Convergent Evolution



2 Models of the pace of evolutionary change

Gradualism	Describes the pattern of flow and gradual change over long periods. Populations slowly diverge from one another due to differing selective pressures. The changes result in transitional forms that are seen in the fossil record.
Punctuated Equilibrium	Describes the pattern of long stable periods in which species stayed much the same. These periods were interrupted by short periods in which the quick pace of evolution rapidly resulted in the formation of new species. The stimulus for evolution is a sudden significant change in the environment.

The fossil record shows that rapid bursts of evolution have been often followed by mass extinction

The Main Point's of Darwin's Theory of Evolution

Overproduction	Organisms have the capacity to produce more offspring than the environment can support.
Competition	There is a struggle for resources among individuals within a population.
Variation	There is a natural variation within populations, meaning individuals within a species are not identical.
Adaptation	Some variations provide advantages in the struggle of existence. Individuals with beneficial traits are more likely to survive.
Natural Selection	Over time, the environment selects those variations that enhance an organism's ability to survive and reproduce. This leads to accumulation of advantageous traits in a population over generations.

The Main Point's of Darwin's Theory of Evolution (cont)

Speciation	Over long periods, the accumulation of differences through natural selection can lead to the formation of new species.

Variations in a species are the result of ***mutations*** in DNA. These mutations are the source of new alleles, the variations upon which natural selection can act.

It is important to remember that mutations are ***random*** in a population, and may produce a change in the phenotype of the organism.

Whether or not the mutation is beneficial or harmful ***depends on the environment***.

Evolution then selects those organisms that are best adapted to their environment at the time

Types of Natural Selection

Stabilizing Selection	Favours individuals with an average value for a trait and selects against those with extreme variations.
Directional Selection	Favours individuals possessing values for a trait at one extreme of the distribution and selects against the average and the other extreme.
Disruptive Selection	Favours individuals at both extremes of the distribution and selects against the average.

Natural vs Artificial Selection

Both natural and artificial selection are mechanisms of change in the gene pool of a population. The key difference is that in artificial selection, humans ensure individuals with the more desirable traits are allowed to reproduce. In natural selection, those individuals who are best suited to their environment survive and reproduce.
Artificial Selection is a form of non-random mating, one of the causes of change to a gene pool.

Three Types of Adaptation

Behavi-oural	How organisms respond to their environment. Eg. Migration, Hibernation, Sunflowers bending towards light.
Physio-logical	Changes in an organisms' metabolic process. Eg. Antibiotic Resistant Bacteria, Pesticide Resistant Insects.
Structural	Adaptations of a physical feature that will increase it's chance of survival. Eg. Whale blubber helps survive arctic waters, webbed feet help water fowl swim better.

2 Types of Structural Adaptation
Mimicry allows for a species to mimic another. The caterpillar larva of the hawk-moth mimics a snake to fool birds.
Camouflage allows for a species to blend with the environment. Stick bugs look like tree branches. Tiger stripes help it blend in the jungle.
Most species see orange as green instead which is why camouflage works.

Acclimatization is not natural selection because an organism becomes accustomed to new environmental conditions.

How can variation alter a gene pool?

Natural Selection	The better adapted individuals survive and reproduce, passing their genes to the next successive generations.
Immigration and Emmigr-ation	Adding or removing individuals from a population will affect allelic frequencies and therefore the gene flow.
Genetic Drift	The change in the gene pool due to random chance.
Non-random mating	Often the case as choice of mates is an important part of behaviour.
Mutations	Occurs constantly. They provide the source of new alleles or variations upon which natural selection can take place.

Hardy-Weinberg Principle Examples and Circulation

In a stable population, the frequency alleles in a population will equal to 1. This can be expressed as $p+q=1$ where:
p = the frequency of the dominant allele
q = the frequency of the recessive allele

Hardy-Weinberg Principle Examples and Circulation (cont)

The Hardy-Weinberg Principle is also useful in explaining why genotypes within a population tend to remain the same, as well as for determining the frequency of a recessive allele. The Hardy-Weinberg Principle equation **($p^2+2pq+q^2=1$)** allows to calculate the frequencies of the three genotypes where:
p^2 = frequency of individuals homozygous dominant
q^2 = frequency of individuals homozygous recessive
$2pq$ = frequency of individuals heterozygous
How to solve:
1- Convert % to decimal and solve for q or p
2- Using the equation $1-p=q$ or $1-q=p$ to solve for the unknown
3- Put in the newfound values of p and q in the equation
It should always add up to 1
Example:
A population of mice has a gene made of 90% *M* alleles (black fur) and 10% *m* alleles (grey fur).
q Recessive Allele = 0.1
p Dominant Allele = 0.9
q^2 Homozygous Recessive = 0.1^2 = 0.01
p^2 Homozygous Dominant = 0.9^2 = 0.81
$2pq$ Heterozygous = 2(0.9*0.1) = 0.18
0.01+0.81+0.18=1

Reproductively Isolated Populations

Speciation	Occurs when members of a populations become reproductively isolated from one another and can no longer produce fertile offspring with each other.
Geographical Isolation (Allopatric Speciation)	Occurs due to the formation of physical barriers that prevent gene flow between the two populations. If the different populations are subjected to different natural selection processes, allelic frequencies for genes will change. The two populations become genetically different that they become two separate species.

Reproductively Isolated Populations (cont)

Niche Differentiation (Sympatric Speciation)	Occurs when the gene flow between members of a populations is restricted due to ecological isolation. Some individuals may be better and adapted to a slightly different habitat in an ecosystem and begin to specialize in that habitat.
Alterations in Behaviour	Should a group of nocturnal mammals become active during the day, they may no longer reproduce with their counterparts who are active at night.

Reproductively Isolated Populations (cont)

Chromosome Mutations	A malfunction in meisosis that can lean to polyploidy in a plant. Because plants can reproduce asexually and self-pollinate, then new polyploidy can reproduce, even though it is reproductively isolated from its parents.

Polyploidy = (multiple copies of chromosomes)

Allopatric vs Sympatric Speciation