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| Adaptive radiation | evolution of a number of divergent species from a common ancestor, each species becoming adapted to occupy a different ecological niche. The original population grows and increases in numbers and expands in size into geographical zones that have different climates. The populations in each habitat adapt to their respective habitats and become new species. Ex Darwin's finches. |
| Advanced characters | of more recent evolutionary origin. These are characters that are derived. Therefore, they are given a number other than zero in cladistics. |
| Allele | an alternative form of a gene, with slightly different DNA than the other alleles of its type. A diploid organism carries two alleles for each locus, one on each homologous chromosome. |
| Allele frequencies | a measure of the commonness of an allele in a population with respect to other alleles of that gene. Abundance of the allele within a population. |
| Allopatric speciation | speciation that results from a physical separation (geographic isolation: fragmentation or climate change) of a population of organisms. The physical barrier prevents gene flow between the two now distinct populations. Therefore, any mutations that arise in one population now can't be shared with the other. This allows for the accumulation of genetic differences making interbreeding impossible. FK GONNA FAIL SOMEONE PLS MAKE HOWARD A SAMMICH |
| Allopolyploidy | polyploidy that result from the fertilization of gametes which had greater than n chromosomes (that weren't haploid). The fertilization can't be self induced. Therefore, the organism must be fertilized by another |

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| | <p>closely related organism to make the zygote. At least one gamete ends up having more than n chromosomes because of mistakes during meiosis or mitosis. This is a deleterious mutation in animals but is beneficial in plants when the chromosomal content is even (ie $4n$, $6n$). If the chromosomal content is odd then the chromosomes can't pair into homologous sets so the hybrid isn't fertile.</p> |
| Anagenesis | <ul style="list-style-type: none"> - the process of microevolution where the change in morphology occurs gradually - it is the slow accumulation of evolutionary changes over time - example; the horse - its ancestor slowly developed hooves and longer limbs for better running capacity and molars (stronger teeth) for better feeding on tough grasses - these changes brought upon by environmental factors and change of diet |
| Apomorphy | <p>a character that was derived by a common ancestor and that all the descendents of the common ancestor possess. This is often used as the defining trait for a species. When many evolutionary taxa share this trait it is termed a synapomorphy. These synapomorphies define the monophyletic groups (ie. Clades). The trait must be a derived trait. Can't be the ancestral trait.</p> |
| Autoapomorphy | <p>This is an apomorphy that is present in only one taxa or clade. It must be a character that was derived from the pleisomorphic state of the common ancestor.</p> |
| Autopolyploidy | <p>: polyploidy that results from the self-fertilization of gametes which have greater than n chromosomes. This unusual number of chromosomes in the gametes, just like in allopolyploidy, results from a mistake in meiosis or mitosis during the formation of the germ cells. Once again, the chromosomal content must be even for the offspring to survive.</p> |

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| Behavioural isolation | A type of pre-zygotic isolation mechanism that results from the different mating behaviour exhibited by the different species. This is a pre-mating type of pre-zygotic isolation mechanism. |
| Beneficial mutation | : a mutation that provides an individual with the mutation a selective advantage over the other individuals in the population. This mutation can be the result of a chromosomal or a point mutation. |
| Biological species | the definition used to determine what a species is and what isn't considered a species. States that a species is a population of individuals that has the ability to interbreed in its natural habitat and produced fertile, viable offspring. The definition of a species works well when trying to define organisms that breed sexually but doesn't work too well when the organisms are asexual because they do not interbreed. With this definition of species the bacteria and the archaea domains of life would have no species. Also this species concept isn't good for classifying fossils (can't go back in time to see if they are capable of reproducing) |
| Bottleneck effect | : a sudden decrease in population density with a resulting decrease in genetic variability within the population. This causes a lot of the alleles in the population to be wiped out and the population will probably have new allele frequencies. This is an example of genetic drift. It reduces the variation in the population and causes some alleles that previously had very low frequencies to have very high ones. The population that expands from the individuals that survived the bottleneck will now have a different allele frequency than the original population. |
| Character polarity | explains the evolutionary change in a character. This describes which character is |

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| | <p>primitive and which is derived. We assign polarity to characters to determine which one came first so that we can determine which species is primitive and which is ancestral. This is the basics of cladistics created by William hennig.</p> |
| Chromosomal Inversion | <p>: is a chromosome rearrangement in which a segment of a chromosome is reversed end to end. An inversion occurs when a single chromosome undergoes breakage and rearrangement within itself at the same position. The chromosome is cut inverted and placed back in the exact same place. This is a type of mutation; can be beneficial deleterious or neutral.</p> |
| Chromosomal mutation | |
| Chromosomal translocation | <p>occurs when a segment of the chromosome is cut and re-inserted in a different non-homologous chromosome at a different location. This is a type of mutation that can be beneficial, harmful or neutral.</p> |
| Clade | <p>A lineage branch that results from the splitting of an earlier common lineage shared by the taxa that branched. The clade is defined by a character that is exclusive to it and all of its members distinguishing it from the rest. An example is a monophyletic group.</p> |
| Cladistics | <p>a method of classification that uncovers genealogic relationships based on the homologous characters that species' share and the polarity of these characters (whether they are derived or ancestral). The species are always compared to a sister group that is considered to be ancestral and all the traits that it possess is also considered to be ancestral. This means that the other organisms similar to it are compared to it to</p> |

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| | determine the phylogenetic tree that represents the relationships between the species. Made by henning. Also created new terms like apomorphy and synapomorphy ect. |
| Cladogenesis | |
| Cladogram | the diagram used to represent the evolutionary relationships between a set of species based on assigned character states. It attempts to uncover the evolutionary sequence of the group of organisms. The nodes represent a common ancestor to the subsequent branches in the diagram. |
| Common ancestor | a species that gives rise to two or more new species. This is the species that evolved into two different species. It represented by a node on a cladogram. |
| Crossing over | is the process by which two chromosomes pair up and exchange sections of their DNA. This often occurs during prophase 1 of meiosis in a process called synapsis. Synapsis begins before the synaptonemal complex develops, and is not completed until near the end of prophase 1. Crossing over usually occurs when matching regions on matching chromosomes break and then reconnect to the other chromosome. The result of this process is an exchange of genes. This is a source of variation in sexually reproducing organisms. |
| Deleterious mutation | a mutation that lowers the fitness of its carriers. Can occur through any of the methods of mutation whether chromosomal or point. |
| Derived character | |

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| Diploid | an organism having one pair of homologous chromosomes (one maternal and one paternal) |
| Directional selection | occurs when selection favours a single phenotype and therefore allele frequency continuously shifts in one direction. Under directional selection, the advantageous allele will increase in frequency independently of its dominance relative to other alleles (i.e. even if the advantageous allele is recessive, it will eventually become fixed). |
| Disruptive selection | changes in population genetics that simultaneously favour individuals at both extremes of the distribution. When disruptive selection operates, individuals at the extremes contribute more offspring than those in the center, producing two peaks in the distribution of a particular trait. This leads to the fixation of the alternative alleles in the population which will result in two divergent phenotypic extremes within the population. This can lead to speciation. |
| Ecological isolation | a type of pre-zygotic isolation mechanism that works because the habitats that the different species live in do not allow for the species to interact with each other and mate to produce offspring. This is one of many processes that can lead to speciation because the now separated populations can't exchange genes (gene flow doesn't occur) meaning that the heritable mutations that occur in the populations will not be shared and the populations will diverge and become different species (maybe). |
| Ecological species | a population of organisms that live in different ecological niches which means that they are different species. They eat, sleep and live in different areas is the determining factor to determine whether the populations are different species. |

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| <p>Female choice</p> | <p>This is a type of sexual selection that occurs when the female decides to mate with males that only have a certain phenotypic trait. This results in an increase in the allele frequency of the allele that is responsible for that trait. An example is the long tail of the birds. This is the reason why males of many species now can be seen to have many bright colors and unique structures that are metabolically expensive but help them attract potential mates. The females use these unique structures on the male to determine if the male is fit enough to mate with so that her offspring are viable. The females must make a careful selection because they invest a lot of metabolic energy into producing offspring than the males.</p> |
| <p>Fixation</p> | <p>occurs when an allele is present in either each individual of a population or none of them (ie. The allele frequency reaches either 1 or 0)</p> |
| <p>Founder effect</p> | <p>genetic differences between an original population and an isolated population offshoot due to alleles in the small number of founder members of the new population being unrepresentative of the alleles in the original population as a whole. This is a type of genetic drift. The new populations allele frequency isn't a proper representation of the parent populations allele frequency.</p> |
| <p>Frame shift mutation</p> | <p>a kind of mutation that causes a change in the translational reading frame as a result of insertion or deletion, usually leads to no or a truncated gene product being produced as a result of a premature termination codon in the reading frame. The produced protein is usually nonfunctional.</p> |
| <p>Gametic isolation</p> | <p>This is a type of pre-zygotic isolating mechanism that occurs when the gametes of the different organisms aren't able to combine</p> |

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| | <p>to form a zygote. The inability of the gametes to combine results from the incompatibility of the receptors present on the surface of the gametes. This means that speciation has occurred between the two populations.</p> |
| Gene duplication | <p>the generation of additional copies of a gene during normal cellular processes such as recombination. Some DNA is taken from one homologous chromosome and added to the other. The mutation is most likely deleterious but is sometimes beneficial. For mammals, haemoglobin is a molecule with a duplicated piece of DNA that the reptiles do not have.</p> |
| Gene flow | <p>the spread of particular alleles within a population and between populations resulting from outbreeding. It ensures that population don't diverge from one another and functions to pass on mutations that occurred in one population to the next. It is also beneficial because it increases variation within the population.</p> |
| Gene pool | <p>all the genes and their different alleles that are present within a given population of organisms. - the sum of all the individual alleles at each gene loci in each individual in a population</p> |
| Genetic drift | <p>random changes in gene frequency in small isolated populations owing to factors other than natural selection. Examples are the bottleneck effect and the founder effect. The allele frequency in these populations does not reflect the original large population's allele frequency because of the reduction of the individuals in the population.</p> |
| Genetic equilibrium | <p>occurs when the allele frequencies of a given gene are kept constant from one generation to the next. This occurs when all the hardy-weinburg assumptions are met. Therefore, the population must be infinitely large, no sexual selection must occur (ie. Random mating), each organism must have an equal chance to pass on its genes to the</p> |

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| | next generation (ie. No natural selection), there must be no gene flow (ie. No new alleles introduced into the population) and no mutations must occur. |
| Genotype frequencies | this is the frequency of a given genotype in a given population. For a gene with two alleles there are three possible genotypes; the homozygous dominant and recessive and the heterozygous. These genotypic frequencies must add up to one. |
| Hardy-Weinberg principle | $p^2 + 2pq + q^2 = 1$ - a null principle used as a reference point to determine whether or not microevolution occurs - based on five assumptions: no mutation, no migration, nonrandom mating, infinite population size and no natural selection (all genes survive and reproduce equally well) |
| Henning | who dis be |
| Heterozygote advantage | the case where the heterozygote for a given pair of alleles is of superior fitness than either of the two homozygous forms. This can be seen in the sickle cell anaemia trait in areas that have high numbers of the malaria disease. The heterozygous individuals have the ability to fight off the malaria better because their red blood cells will sickle killing the malaria parasite and slowing its spread within the body. |
| Heterozygous | The condition when the genotype at a given locus has different types of alleles for the same trait. |
| Homology | resemblances due to common descent. The traits are homologous and occur due to divergent evolution. |

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| Homoplasy | resemblances between organisms due to evolution along different lines rather than common descent. Traits are analogous and occur due to convergent evolution. |
| Homozygous | structures that resemble each other because of common ancestry. Occur do to divergent evolution. The structures share a homology. The structures can have different functions. |
| Hybrid breakdown | this is a type of post-zygotic isolation where the hybrid that is formed is fit to survive the environment but the F2 generation that is produced is not viable or isn't fit. The F2 generation can be produced either by the mating of two hybrids or by the hybrid and the original parent species. |
| Hybrid viability | : this occurs when the hybrid that is produced is perfectly fit and is able to live and reproduce in its environment. In ring species this can sometimes lend itself into creating a hybrid zone where only the hybrid lives. However sometimes, the hybrid is even more fit than any of the parent species and is able to out compete them and form one large species. |
| Hybridization | is the process of creating a new species by the mating of different species or sub species. The hybrid formed can either be inviable, sterile or fit. The parent species must be genetically different from each other. |
| Inbreeding | mating between related individuals. This results in an increase in homozygosity of the genotypes. However, it does not alter the allele frequencies of the population. |
| KISS principle | : The principle that is used when trying to resolve conflicts in cladistics. The principle states that the explanation of the occurrence is the explanation that requires the least amount of evolutionary change to have occurred. This is also called parsimony. |

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| Male competition | a type of intrasexual competition that males do between each other to be able to mate with the female. There are three primary types; combat, sperm competition and infanticide. Combat occurs when males physically fight each other to eliminate the other male from the picture so that they can have exclusive rights to mating with a female. Sperm competition occurs when a male will remove the sperm of the previous male that mated with the female and then will inject his sperm into the female. He will then stay to make sure that the female doesn't mate with another male that will reduce the chances that his sperm will fertilize the egg. Finally, infanticide occurs when the male kills all the offspring that were produced from a different male so that the female can stop nursing her cubs and start her reproductive cycle again. This allows him to mate with the female and pass on his genes. |
| Mechanical isolation | : a type of pre-zygotic isolation mechanism that doesn't allow the sperm of the male to meet the sperm of the female. It occurs because of a physical inability to join the reproductive parts of the different species and for the male to inseminate the female. |
| Microevolution | evolutionary change consisting in the altering of allele frequencies in a population. Can be determined if it has occurred based on taking samples and putting the numbers into the hardy-weinburg equation. |
| Migration | the movement of individuals between different populations of species that results in gene flow. This is beneficial because it increases variation in the two populations. |
| Missense mutation | a point mutation in which the base pair that is substituted changes the amino acid that the codon codes for. This changes the resulting |

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| | protein configuration making the protein potentially useless. |
| Modern theory of evolution | <ul style="list-style-type: none"> - the theory of evolution proposed in the 1900's after Mendel's work was rediscovered - was developed when known information of genetics was applied to support the last three of Darwin's five theories |
| Monophyletic | |
| Morphospecies | a group of organisms that have individuals that differ in morphology but are grouped together for analytical purposes: Bad for classifying the nematodes and some birds. Good for identifying species in the wild. Good for classifying the fossils. |
| Mutation | : a change in the genetic sequence or structure of an organism that happens through an error in the genetic replication or combination mechanisms. |
| Natural selection | <p>the selection of particular traits within a population that occurs because the individuals that possess these traits are better adapted to their habitat and therefore are better able to reproduce and pass on their genes to their offspring. It results in the increase in the allele or genotype that is being selected for.</p> <ul style="list-style-type: none"> - the evolutionary process by which alleles that increase the likelihood of survival and the reproductive output of the individuals that carry them become more common in subsequent generations - favourable traits → survival → reproduction - unfavourable → die → no reproduction - traits are amplified as time passes with more generations - weak traits dwindle - eliminates unsuccessful variants - evolution occurs as some organisms simply function better than others in certain environments |
| Neutral mutation | a mutation which confers no selective advantage or disadvantage. |

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| Non-random mating | mating between organism in which one of the organism makes a conscious choice to mate with a partner having a certain phenotypic trait. Sometimes females can choose what type of males they want to mate with or sometimes males will compete with each other to determine which male will get to mate with the female(s). |
| Nonsense mutation | mutation which generates one of the termination codons: UAA, UAG, or UGA resulting in the premature termination of polypeptide synthesis during translation. |
| Out group | |
| Parapatric speciation | a type of speciation that occurs when the populations of organisms live in different habitats adjacent to one another. The hybrid that is produced isn't viable in either habitat so it will die. This further enables natural selection to enhance the isolation mechanisms by which the species will not reproduce. |
| Paraphyletic | : a group which has evolved from and includes a common species but which doesn't contain all the descendants of the ancestor. It occurs when a problem is found in the cladogram of the biologist. Someone else proposes a better way to construct the cladogram with different traits and then the descendant is found. Sometimes done on purpose for simplicity purposes. |
| Parsimony | the principle that an evolutionary sequence must take on the form that requires the least amount of evolutionary events to have occurred. |
| Phylogenetic species | the concept that states that a species is an irreducible group of organisms that share a common ancestor. It runs into a problem |

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| | because it doesn't specify where the breaking apart of organisms stops. There is always variation between a population so when do you stop branching? |
| Phylogenetic taxonomy | classification based on evolutionary relationships in which all taxa aim to correspond to monophyletic groups. The taxonomy should be the same based on the different characters that can be used to determine which organism came first and which came later on. |
| Phylogeny | -evolutionary history of a group of organisms |
| Plesiomorphy | the original, pre-existing member of a pair of homologous characters. It is the primitive trait that is possessed by the out group and other taxa like it. This trait cannot be used to define the organism. |
| Point mutation | mutation resulting in the change of a single base pair. Can be an addition, deletion or substitution. Addition and deletion result in frameshift mutations while a substitution results in a missense, nonsense or silent mutation. |
| Polyphyletic | a taxonomic group that includes several different lines of descent. This occurs when the common ancestor for the different taxa can't be found. Is also sign of convergent evolution. The convergent trait that groups these species' together is wrong to make us think that the species' are related to each other. This is why when other characters are used a different cladogram is constructed |
| Polyploidy | is a state different from most organisms which are normally diploid meaning they have only two sets of chromosomes - one set inherited from each parent; polyploidy may occur due to abnormal cell division (no cell division during mitosis so meiosis makes diploid gametes). It is a chromosomal mutation. It is most commonly found in plants and is usually beneficial in plants. Can occur |

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| | <p>it two ways; autopolyploidy or allopolyploidy. Auto occurs when a plant fertilizes another plant of the same species and ends up with more than the diploid amount of chromosomes in the zygote. Allo occurs when the offspring is a hybrid and makes a mistake when doing mitosis and doesn't divide. Therefore, the zygote is tetraploid.</p> |
| Population | <p>all the individuals living in the same area and are interbreeding.</p> |
| Population genetics | <p>the genetics that studies the allele frequencies of populations of organisms</p> |
| Postzygotic isolation mechanisms | <p>: isolation mechanism in which the zygote that is produced isn't viable (the hybrid zygote doesn't mature into an adult individual), isn't able to reproduce (the hybrid is sterile) or breaks down (the F1 hybrid is functional and fit but as soon as it reproduces the offspring isn't viable)</p> |
| Prezygotic isolation mechanisms | <p>isolating mechanisms between different species that do not allow the species to breed with each other and form a zygote. They are; mechanical, ecological, temporal, gameteic and behavioural.</p> |
| Primitive character | <p>(basal characters) earliest clade to branch in a larger clade. The out group consists of only primitive characters. Assigned the number zero in the process of creating a cladogram (ie. Cladistics). When share by many taxy are referref to as sympleiomorphies.</p> |
| Punctuated equilibrium | |
| Punnett square | |
| Recessive allele | <p>the allele that isn't able to express itself when</p> |

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| | paired with a different form of the allele. |
| Reinforcement | the process by which the hybrid formed between two different populations isn't able to survive so the isolation mechanisms between these two populations continues to increase and the idea that speciation has occurred is reinforced. |
| Reproductive isolation | occurs when two different populations aren't able to mate with each other and make fertile and viable offspring. Can be pre or post zygotic. |
| Ring species | a species that has a geographical zone that it lives in where there is a center zone where the species doesn't exist because the environment doesn't allow it to live in that area. The sub species in the different areas of the ring have adapted to different environments and this means that they are on their way to becoming different species. The species can reproduce with each other only where their habitats overlap. The hybrids formed might be viable or might not. The sub species have all come from a common ancestor. If the hybrid isn't viable then we call this reinforcement. Speciation has occurred. Sometimes the hybrids are viable and a hybrid zone is made and sometimes the hybrid is better adapted to the environment and out competes the parent species'. |
| Sexual dimorphism | the systematic difference in form between individuals of a different sex in the same species. |
| Sexual selection | the difference in the ability of individuals of different genetic types to acquire mates, and therefore the differential transmission of characteristics to the next generations. |
| Sickle cell anaemia | disease developed when a person is homozygous for the sickle cell mutation in the gene for B-globin. An abnormal haemoglobin is produced which causes sickling. |

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| Silent mutation | a mutation which has no effect on the individual |
| Sister group | Another name for the out group that has all the primitive characters. |
| Speciation | the evolution of new species. |
| Sperm competition | -males that get to the female first are more likely to produce offspring with that female than the 2nd or 3rd male -ex. dragonflies stay attached to females |
| Stabilizing selection | also referred to as purifying selection, is a type of natural selection in which genetic diversity decreases as the population stabilizes on a particular trait value. Put another way, extreme values of the character are selected against. This is probably the most common mechanism of action for natural selection. |
| Subspecies | a population of organisms that are designated as a sub species because they have diverged from the parent species and now live in a different geological area. This means that they don't reproduce with the original parent species. However, where the geographical zones overlap the sub species have the ability to produce offspring. (ex ring species) |
| Sympatric speciation | speciation that occurs while the populations are still living in the same habitat and become reproductively isolated. Usually happens when the organisms start adapting to different food sources and end up mating with the individuals that are doing like them. |
| Symplesiomorphy | where a homologous character state shared between two or more taxa is believed to have originated as a novelty in a common ancestor earlier than the most recent common ancestor. This is the most primitive trait in the cladogram. |
| Synapomorphy | : a homologous character common to two or more taxa and thought to have originated in |

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| | their most recent common ancestor. This character is a derived character and isn't possessed by the out group. |
| Synthetic theory of evolution | |
| Systematics | a type of taxonomy based of evolutionary rules - reconstructs the phylogeny of organisms |
| Temporal isolation | : pre-zygotic isolation where the time of reproduction of the respective species is different. Therefore, the species can never breed with each other. |
| Triploid | when an organism has three sets of homologous chromosomes |
| Vicariance | a geographical separation of a species that usually will end up resulting in speciation. This is a type of allopatric speciation because the population are geographically isolated. |

YOU GUYS OWE ME. GONNA FAIL ANATOMY HAHAHAHAHAA

- Adaptive radiation
- Advanced characters
- **Allele**
 - one of two or more versions of a gene
 - produce traits of character
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- Allele frequencies
- Allopatric speciation
- **Allopolyploidy**
 - genetic condition of having two or more complete sets of chromosomes from different species
 - chromosomes will not pair properly in meiosis
 - happens at the start of mitosis, doubling homologous chromosomes
- Anagenesis
- Apomorphy
- Autapomorphy
- **Autopolyploidy**
 - error in either mitosis or meiosis
 - spontaneous doubling of chromosomes producing diploid gametes
- Behavioural isolation

- **Beneficial mutation**
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- Biological species
- **Bottleneck effect**
 - disease, starvation or drought kills many individuals and eliminates some alleles from the population
 - cause of genetic drift reduces genetic variation
 - endangered species
- Character polarity
- **Chromosomal Inversion**
 - chromosomal alteration that occurs if a broken segment reattaches to the same chromosome from which it was lost
 - in reversed orientation so the order of the genes in the segment is reversed with respect to the other genes of the chromosome
- **Chromosomal mutation**
- **Chromosomal translocation**
 - occurs if a broken segment is attached to a different non homologous chromosome
- Clade
- Cladistics
- **Cladogenesis**
- Cladogram
- **Common ancestor**
- **Crossing over**
- **Deleterious mutation**
 - alter an individual's structure, function or behavior in harmful ways
 - lethal mutation is the cause of death (if lethal allele is dominant both homozygous and heterozygous suffer)
- Derived character
- Diploid
- **Directional selection**
 - individuals near one end of the phenotypic spectrum have the highest relative fitness
 - Shifts a trait away from the existing mean and toward the favored extreme
 - After the selection, trait's mean value will be higher or lower than before depending on direction
- **Disruptive selection**
 - extreme phenotypes have higher relative fitness than intermediate phenotypes
 - Alleles producing extreme polymorphism, under natural conditions disruptive selection is much less common
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- Ecological isolation
- Ecological species
- Female choice
- **Fixation**

- occurs when selection pressure is strong and a specific gene/trait is fixated into a population, eliminating the other possible variation of that gene.
- ex. superbug. bacteria that can metabolize the antibiotic produce offspring with this gene (this gene is fixated) and the bacteria that have the gene that cannot metabolize it do not reproduce and that trait disappears
- **Founder effect**
 - loss of genetic variation that occurs when a new population is established by a very small number of individuals form a larger population
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- **Frameshift mutation**
 - if a single base pair is deleted or inserted in the coding region, the reading frame results mRNA altered
 - ribosomes read codons that are not the same as for the normal mRNA producing completely different amino acid sequence in the polypeptide
- Gametic isolation
- **Gene duplication**
 - occurs if a segment is broken from one chromosome and inserted into its homologue, in receiving homologue, the alleles in the inserted fragment are added to the ones already there
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- **Gene flow**
 - change in allele frequencies as individuals join a population and reproduce
 - violates Hardy-Weinberg condition that populations must be closed to migrate, if immigrants reproduce they may introduce novel alleles into the population
 - will mostly affect two gene pools that are very different where a little gene flow will increase genetic variability that receives immigrants (both populations become more similar)
- Gene pool
- **Genetic drift**
 - events that cause allele frequencies in a population to change unpredictably
 - violates Hardy-Weinberg condition of infinite population size
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- Genetic Equilibrium
 - the point at which neither allele frequencies or genotype frequencies change in succeeding generations
- **Genotype** frequencies
- **Hardy-Weinberg principle**
 - (null model: evolution may occur))- specifies conditions under which a population of diploid organisms achieves genetic equilibrium (the point at which neither allele frequencies or genotype frequencies change in succeeding generations), dominant alleles

did not need to replace recessive ones, shuffling genes in sexual reproduction does not change the gene pool

- conditions
- 1. No mutations occur
- 2.the population is closed to migration from other populations
- 3.population is infinite in size
- 4. All genotypes in the population survive and reproduce equally well
- 5.individuals in the population mate randomly with respect to genotypes
- if conditions are met the allele frequencies of the population for an identified gene locus will never change and the genotype frequencies will stop changing after one generation
- in these restrictive conditions, microevolution will not occur
- Henning
- Heterozygote advantage
- Heterozygous
- Homology
- Homoplasy
- Homozygous
- Hybrid breakdown
- Hybrid viability
- Hybridization
- Inbreeding
 - special form of nonrandom mating in which individuals that are genetically related mate with each other
- KISS principle
- Male competition
- Mechanical isolation
- Microevolution
 - evolution that occurs due to changes in gene frequencies within a population
- Migration
- Missense mutation
 - if a mutation alters a codon to specify a different amino acid
 - the protein will have a different amino acid sequence
 - missense mutation in the gene for one of the two hemoglobin polypeptides results in sickle cell anemia
- Modern theory of evolution
- Monophyletic
- Morphospecies
- Mutation
 - changes in sequence of genetic material
 - can affect protein structure and function
- Natural selection
 - differential survivorship or reproduction of individuals with different genotypes

- process by which such beneficial, heritable traits become more common in subsequent generations
- violates Hardy-Weinberg equilibrium
- **Neutral mutation**
 - DNA sequence changes (especially certain changes at the third nucleotide of the codon) do not alter the amino acid sequence
 - may change phenotype without affecting its survival and reproduction
 - can be beneficial or detrimental later if environment changes
- **Non-random mating**
 - choice of mates based on their phenotypes and genotypes
- **Nonsense mutation**
- mutation changes a sense (amino acid coding) codon to a nonsense (termination) codon in mRNA
- Out group
- Parapatric speciation
- Paraphyletic
- Parsimony
- **Phenotype**
- Phylogenetic species
- Phylogenetic taxonomy
- Phylogeny
- Plesiomorphy
- **Point mutation**
- Polyphyletic
- **Polyploidy**
- Population
- Population genetics
- Postzygotic isolation mechanisms
- Prezygotic isolation mechanisms
- Primitive character
- Punctuated equilibrium
- **Punnett square**
- **Recessive allele**
- Reinforcement
- Reproductive isolation
- Ring species
- Sexual dimorphism
 - differences in size or appearance of males and females
- **Sexual selection**
 - interior sexual selection (males and females) males produce useless structures to make females attracted, intrasexual selection (members of the same sex) such as size to be bigger than others to kill

- **Sickle cell anaemia**
 - missense mutation in the gene for one of the two hemoglobin polypeptides results in sickle cell anemia
- **Silent mutation**
 - degeneracy in the genetic code, some base-pairs substitution mutations do not alter the amino acid specified by the gene because the changed codon specifies the same amino acid as in the normal polypeptide
- Sister group, Speciation
- **Sperm competition**
- **Stabilizing selection**
- Subspecies
- Sympatric speciation
- Symplesiomorphy
- Synapomorphy
- **Synthetic theory of evolution**
- Systematics
- Temporal isolation
- Triploid
- Vicariance

Summary of the modern theory lectures up to slide 55

Fixation—selection pressure

- Usually on manmade circumstances lead to this
- Classic case of Darwinian selection process
- The **selection pressure** causes this: a gene allele gets very low in population, to the point of fixation. So that the other allele exist in the population.
- Ex. The antibacterial resistance drugs in hospitals. These bacteria are hit with antibiotics, so those that can withstand the antibiotic survive and the allele that makes bacteria not resistant is low.
- Ex. Tuberculosis, gonorrhea, malaria

Effects of selection against recessive

- The case where recessive allele homozygous individual has a characteristic that makes it less likely to survive
- The frequency of the recessive allele will decrease and at the same rate the frequency of the dominant allele will increase
- The recessive allele frequency in the population will NEVER reach ZERO because there is always a heterozygous individual out there with the recessive allele, but they just have the phenotype of the recessive homozygous individual
- Ex. Beetle slide 15

Heterozygote advantage

- Malaria –multiplies in the red blood cells

- In sickle cells, a single point mutation, the cell doesn't have the round shape and can't carry oxygen effectively
- Heterozygous for sickle cell → leads to difficulty and potentially death in populations >> thus low incidents of sickle cell
- But in other parts of the world, some parts of Africa there are high incidents of the malaria gene because it gives an advantage for survival
- Body recognizes these sickle cells and gets rid of them via liver. Malaria parasite invades red blood cells, so when you have sickle cell anemia, then at the same time, the body kills the malaria >> giving an advantage in survival.

Polygenic traits

- Multiple loci traits
- Can't measure the allele but can make a graph of distribution of species >> Can measure the phenotypic variation
- +/- 95% meaning 95% of our samples fall within the standard deviation???
- ex. Mean is at 3.8 and +/- is the measure of the spread from the mean
- **sampling:** more measurement we take to alleviate sampling error, the more our distribution will fixate at a shape that won't change over time

Directional selection of multiple loci traits

- ex. Male birds with long tails are preferred by females over those with short tails
- so they get more action → pass on their genes to the next generation → the distribution graph shifts. It will often keep the same mean and the same spread.

Stabilizing selection

- not too big, not too small >> the middle is preferred
- extremes start to disappear
- the mean stays in the same place, but the range/ 95% value / distribution will decrease.
- Ex. Baby weight from textbook

Goldernrod example

- o Fly injects egg into stem, out of the egg comes out a maggot, chewing away from the stem.
- o In its salivary gland releases plant growth hormone >> making a cancer like tumor on the stem of the plant
- o The maggot comes out of the tumor at the end of the season
- o Now there is a waste, it places egg inside the maggot, eating it from inside to out, but at the same time secretes fly growth hormone.
- o If the gall is too big, woodpeckers manipulate them (maggot inside them dies). If the gall is too small, it gets attacked by the wasp.
- o So there is a selective pressure that ensures the size of the gall is medium > where most survival of the maggot occurs >> known as stabilizing selection

Disruptive selection

- Beak sizes vary based on the size of the seeds
- Large beaks > for large seeds and vice versa
- We have a normal distribution of beak sizes
- In the Galapagos islands, a drought caused plants creating medium size seeds to decrease in

number >> caused disruptive selection of beak sizes

- Small and big beak sizes became prevalent and medium beak sizes decreased in numbers
- When drought was over, medium size seeds came back, and so did birds with medium size beaks >> normal distribution restored.
- All happens fairly fast > doesn't require millions of years

Mutation

- Usually doesn't cause evolutionary change >> because of redundancy of genetics code
- A change in one nucleotide in a codon might still give you the same amino acid
- Mutations can be: **beneficial, neutral, deteriorus**
- Point mutations:
 - o Silent: a mutation where it causes no change in the amino acid sequence. Makes sense> it's silent.
 - o Missense: a point mutation (1 nucleotide changes), producing a new amino acid.
Ex. sickle cell anemia. GAG (normal) > glucine you get GTG (abnormal)> valine.
Ex. Instead of ABC producing "bird" amino acid you have ADC producing "car" amino acid
 - o Nonesense: Codes for a stop codon.
 - o Frame shift:.... Causes an addition of a specific nucleotide, or the the entire sequence shifts.

Chromosome mutation (one sentence description is enough)

- Inversion: The gene or the part of the chromosome detaches and then reattaches, and becomes reversed in the end.
- Translocation: Rettaches on another chromosome.
- Deletion:A part of the chromosome dissappears or goes missing.
- Duplication:Dupilcates,
- Crossing over: In meiosis, the chromosomes cross over and exchange information changing the gene frequency for the next batch of offsprings.
- Polyploidy:Having more than one chromosomes after mating. Plants do this stuff all the time.
- Genome duplication: Duplicates.

Crossing over

- The biggest factor that leads to mutation

Autopolyploid

- Happens in plants >> makes new speicies that can now only mate with each other now

Polyploidy

- Large numbers of chromosomes >

Allopolyploid

- Wheat has three genomes Different species are createed.

Sources of variation: major ones

- Mutation (little)
- Meiosis (crossing over, and some are polyploidy)

Hardy Weinberg assumptions:

1. No natural selection

2. No mutation
3. No genetic drift—population is large
4. Gene flow
5. Random mating

No genetic drift—population is large

- If we don't have a proper sample >> a population size is very small >> then the frequencies will not be representative

Genetic drift—The bottle neck affect “decrease in population in same place”

- Population of organisms that has undergone a natural catastrophic event that has brought the number of individuals to a few who are still in the same location/circumstance
- Much genetic variability is decreased in the same location
- Ex. American bison: were the dominant herbivores in the prairies. Hunted by Europeans to the point of close to extinction. They are being reintroduced now but they all are coming from the 750 that were left. We are seeing that they are not resistant to a lot of diseases because there is very little genetic variability out there.
- Happens in conservation attempts: were they breed species in a zoo, but when it's released, they are so genetically unvaried that they die as soon as they are released into the natural environment.
- Result of: Habitat destruction or animals being isolated from one another

Genetic drift—the founder affect “got up and went to a diff place”

- Ex. Around quebec city, the colonists there came from a particular region from France, that population boomed to ¼ of million individuals. Because of isolation and religion—the inbreeding led to inherent diseases increases like Muscular dystrophy.
- Common in isolated groups (geographically or religious or cultural)
- Small population moves to a different place >> only part of the allele variety is in that region.

Gene flow—opposite of genetic drift

- 2 isolated population that have diff genetic make ups (sub populations) >> maybe a result of bottle neck affect or the founder affect
- If you create gene flow between these populations >> increases variation available b'w those populations
- If you can connect 2 separate populations through migration>> over time, the allele frequencies will homogenize and >> stabilize the allele frequencies

Gene flow—“Y to Y” connections

§ Designed so that populations don't get isolated from each other (founder affect)

§ Y to Y > yellow stone to Yukon

Non random mating—inbreeding

- Small population of families that reproduce with each other
- Ex. Royal family > hemophilia. They were either homozygous hemophiliac or homozygous not hemophiliac, less or no heterozygotes
- Mandel used to develop pure strains
- Heterozygotes start to disappear and homozygotes recessive and homozygous dominant increase >> drive to 2 extremes >> is it evolutionary? NO. the # of alleles didn't change—they

simply reorganized.

Non random mating—sexual dimorphism

- If you are a healthy bird, you can spend some of your metabolic load to put on features and colours (spare metabolic cash) >> the female sees this as a good sign that the male makes viable sperm
- FEMALES: produce a limited # of eggs > so you want to condition all the eggs
- MALES: make sure it mates with as many females as it can >> has lots of sperm

Non random mating: Sexual selection

- 1) Females make a choice OR
- 2) Males make the choice by competing for the female:
 - a. Combat
 - b. sperm competition
 - c. infanticide

1. i) Appearance of male—female choice

- a. artificially manipulated the length of the tails >> those with longer tails >> mated more >> even though they might not be more fit/superior
- b. result = genes of those with long tails are increased in the population

ii) certain actions

ex. male bird « dancing »

2. Male combat

Ex. in seals > a few males that mate with ALL the females >> an extreme example of sexual selection based on combat

Sexual competition—Sperm competition

- Competing males to mate with a female first
- Clasps the female, stays attached to her, to ensure that his sperm will be the first that is there

Sexual selection—infanticide

- In lions, When a male is challenged by another male, the defeated male lion leaves
- The children of the lion that lost the battle have that guy's genes >> so the new male kills them
- And the females now mate with the new male and his genes are passed on
- Allele frequencies change in a population