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| **Speciation -** the origin of new species   * One species splits into two or more speciesa * a population’s genetic divergence from its ancestral population results in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * Leads to **macroevolution** (broad patterns of evolutionary change above the species level; cumulative effect of many speciation and extinction events as evidenced in the fossil record), major morphological transformations * **Speciation explains the differences (diversity) of life and also the similarities between them (unity)** * Evolutionary theory must explain how new species originate and how populations evolve   How and Why?  **Populations become isolated and then isolated populations evolve independently** | | |
| Reproductive Isolation – plays key role in speciation   * Gene flow – the transfer of alleles between populations holds populations together genetically * The absence of gene flow (reproductive isolation) plays a key role in speciation * the existence of biological factors (barriers) that impede two species from producing viable, fertile offspring; isolate gene pools of species by blocking \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Obstacles to mating or fertilization if mating occurs | | |
| Prevent Mating | 1. | **Species occur in different areas, physical barrier**  Allopatric (squirrels on N vs S rim of G. Canyon) |
| 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  or  ecological | **species occur in same area, but occupy different habitats and rarely encounter each other**  (terrestrial vs. water snake in same area) |
| 3 | **species that breed during different times of say, seasons, years so can’t mix gametes**  (skunks mating in late winter vs. late summer) |
| 4 | **Unique behavior patterns**, courtship rituals, etc**. isolate species**  Identify own species (mate recognition)  (Blue footed boobies courtship display) |
| Unsuccessful Mating | 5 | **Morphological differences prevent successful mating**   * Lack of fit between males and females of closely related species * Distinction in plants to attract different pollinators * (opposite spirals of 2 varieties of snails, reproductive openings don’t line up) |
| Mating but no zygote forms | 6. | **Sperm of one species may not be able to fertilize eggs of another** (can’t survive in female reproductive tract, sperm can’t penetrate into egg) |

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| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Prevent hybrid offspring from developing into viable, fertile adults | | |
| 1. |  | Genes of the different parent species may interact & impair the hybrid’s development  (hybrid frogs or salamanders don’t complete development or are frail and don’t survive long) |
| 2. |  | Even if hybrids are vigorous  they may be sterile  (mule with 63 chromosomes I chromosome number in parents may differ and hybrids fail to produce viable gametes) |
| 3. |  | Hybrids may be fertile & viable in first generation, but when they mate offspring are feeble or sterile  On path to separate species |

Various species concepts:

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|  | A species is a population or group of populations whose members have the potential to interbreed with each other in nature to produce viable, fertile offspring, but who cannot breed successfully with members of other species.  Limits:   * cannot be applied to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ organisms (including all prokaryotes) * often lack the information on interbreeding * emphasizes absence of gene flow   + gene flow can occur between distinct species |
|  | defines a species by a unique set of structural features |
|  | defines a species in terms of its ecological niche (set of environmental resources that a species uses and its role in a biological community) |
|  | defines a species as the smallest group of individuals that share a common ancestor (on a phylogenetic tree) |

Modes of Speciation

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| Allopatric | Sympatric |
| a population is divided by a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ barrier   * Restricts gene flow between populations * Separate populations may then evolve independently (as there gene pools diverge – different mutations, natural selection varies) * Barriers vary based on ability of population to disperse * Reproductive isolation may then arise (even if contact is restored) | speciation occurring in geographically overlapping populations (reproductive barriers exist without physical separation)  they still live in the same area |
| Pairs of sibling snapping shrimp separated by the isthmus of Panama  Ring species distributed around a geographic barrier with some hybrid zones no longer interbreeding  Adaptive radiation on island chains – the evolution of diversely-adapted species from a common ancestor  Regions with many geographic barriers typically have more species than do regions with fewer barriers | **In plants:**   * **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ -** accidents during cell division that result in extra sets of chromosomes * Many important crops (oats, cotton, potatoes, tobacco, and wheat)   **Autopolyploid -** an individual with more than two chromosome sets, derived from \_\_\_\_\_\_\_\_\_ species; chromosome number doubles  **Allopolyploid -** a species with multiple sets of chromosomes derived from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species;  Chromosome number is additive |
| **In animals:**   * Usually the result of **habitat differentiation and mate preference** (sexual selection) |

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| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ zone -** a region in which members of different species mate and produce hybrids | | |
| **Hybrids**   * + the result of mating between species with incomplete reproductive barriers   + often have reduced fitness compared with parent species = poor survival and reproduction = few viable offspring 🡪 often rare | | |
| A hybrid zone can occur in a single band where adjacent species meet; Also occur as favorable “patches” with a very particular set of environmental conditions | | |
| **Three possible outcomes:** | | |
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| *Strengthening Reproductive Barriers* | *Weakening Reproductive Barriers* | *Continued Formation of Hybrid Individuals* |
| *when hybrids are less fit than the parent species*  *Over time, the rate of hybridization decreases*  *Where reinforcement occurs, reproductive barriers should be stronger for sympatric than allopatric species* | If hybrids are as fit as parents, there can be substantial gene flow between species  If gene flow is great enough, the parent species can fuse into a single species  Speciation process reverses | Extensive gene flow from outside the hybrid zone can overwhelm selection for increased reproductive isolation inside the hybrid zone |

**Rates of Speciation**

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| Gradual divergence over long spans of time   * + assume that **big changes occur as the accumulation of many small ones**   + **Darwin & Lyell** | Rate of speciation is \_\_\_\_\_ constant   * rapid bursts of change * long periods of little or no change * species undergo **rapid change when they 1st bud from parent population** * **Gould & Eldredge** |