G11.4B – Evolution 3 – Genetic Variation

Evolution is defined as genetic change of a population over time.

CIE Biology Jones p402 to 418

Extra help

A nice IB slide player ppt
http://slideplayer.com/slide/9686564/

Understanding Evolution Website
https://evolution.berkeley.edu/evolibrary/article/evo_14

Mrs Cooper A level Biology Variation (8 min)
https://www.youtube.com/watch?v=tKQXnU1Pgow

Mrs Cooper A level Natural Selection (16 min)
https://www.youtube.com/watch?v=AtlERbtrIzM

Learning Objectives

11.2.6.3 explain the relationship between genetic variation and evolution

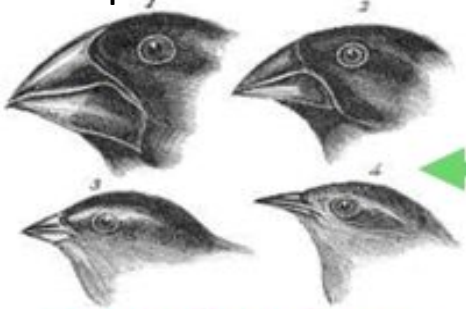
Success Criteria

1. Name at least three ways in which the initial population can change
2. Use natural selection to explain results of a certain change in natural environment.
3. Explain relationship between genetic variation and evolution.

Vocabulary: Evolution, natural selection, speciation, artificial selection

English	Google Russian ☺️
Natural Selection	Естественный отбор
Variation	варьирование
Frequencies	частоты
Allelic frequencies	аллельных частот
Hybrid	Гибридный
polypoloidy	polypoloidy
Speciation	**видообразование**
Sympatric	симпатрического
Allopatric	аллопатрических
Peripatric	Peripatric
Parapatric	Perapatric
Mechanisms = Factors	**Механизмы** = Факторы
Mutation	перегласовка
Migration (emigration / immigration)	миграция
Genetic drift	Генетический дрейф
Non-random mating	Неслучайное спаривание
Selection and survival of the fittest	Выбор и выживание наиболее приспособленных
Stabilizing	стабилизирующий
Disruptive	разрушительный
Directional	направленный
Hardy Weinberg	Hardy Weinberg
Gene flow, gene drift, gene pool	Поток генов, дрейф генов, ген бассейн
Isolation (mechanical, temporal, geographic, behavioral, gametic)	Изоляция (механические, временные, географические, поведенческие, гамет)
Pre-zygotic mechanisms	
Post-zygotic mechanisms	

Adaptive radiation



Evolution at a Glance

Graphic Organizer

Geographic Isolation → Reproductive Isolation

Reproductive Isolation → Failure to adapt → Disruptive Selection

Reproductive Isolation → Adaptation → Natural Selection → Speciation

Speciation → Happens quickly → Punctuated Equilibrium

Speciation → Happens slowly over a period of time → Gradualism

Speciation → Same species in different environments evolve in to 2 new species → Divergent Evolution

Reproductive Isolation → Characters to adapt selected by humans → Artificial Selection

Two different types evolve to adapt same conditions → Convergent Evolution

11.2.6. 3 Explain the relationship between genetic variation and evolution

Population Important information

- To study the inheritance of a trait, we study and individual.
- To study the genetic frequency of alleles, we study a population.
- The study of a population is called the measurement of variability.
- A population with **high genetic variability** has more evolutionary success, where as a population with **low genetic diversity** has a low evolutionary success and could quickly reach extinction if there is a change in the environmental conditions.

Genetic Variation ***What can cause change in a population?***

In order for natural selection to occur, there must first be inheritable variation in traits within a population. **Genetic variation** describes the differences between the genetic make-up of individual organisms and accounts for the diversity of features seen both within, and between, species

- There are a number of sources of genetic variation within a population, including:

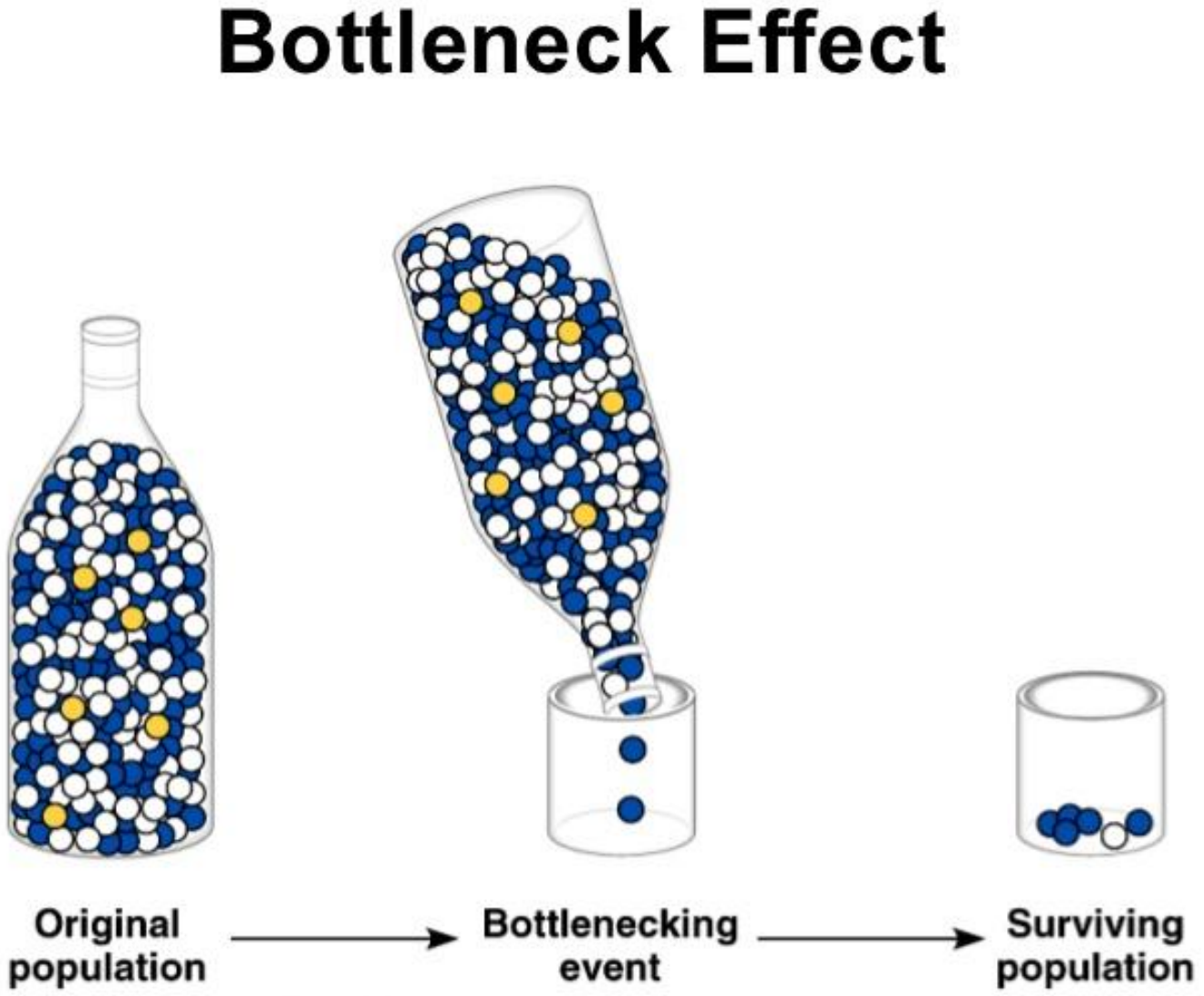
- **Gene mutations:** A change in the DNA sequence of a gene which may alter the expression of the associated trait
  - A gene mutation may only be inherited if it occurs within germinal tissue (i.e. the cells responsible for gamete production)
- **Gene flow:** The introduction of new alleles into a population as a result of the immigration of new organisms into a population
  - Gene flow can also be used to describe the removal of alleles from a population as a result of emigration
- **Sexual reproduction:** The combination of alleles to form new traits as a result of random mating
  - Variation can also occur in sexually reproducing organisms as a result of *crossing over* (gene recombinations) during prophase I of meiosis
  - Variation can also be created as a result of the *random orientation of chromosomes* (independent assortment) during metaphase I of meiosis

Sources of Variability – how does it lead to adaptation?

Can you state with examples the 5 types of variation?
What is the relationship between natural selection and variation?
How does variation lead to evolution?

- Mutation, meiosis and sexual reproduction causes variation between individuals in a species
- Natural selection can only occur if there is variation among members of the same species

Reduction in the number of alleles in a population due to a catastrophe or excessive hunting



Low Genetic Variation – less evolutionary success.

Cheetahs went through a large reduction leaving a small population with little genetic variation.

Northern Elephant Seals have reduced genetic variation due a massive reduction of their population (20 individual) at the end of the 19th century. Now they have rebounded to over 30,000, but they have little genetic variation.

Less variation – less chance of adaptation for survival, less evolution success

Definition

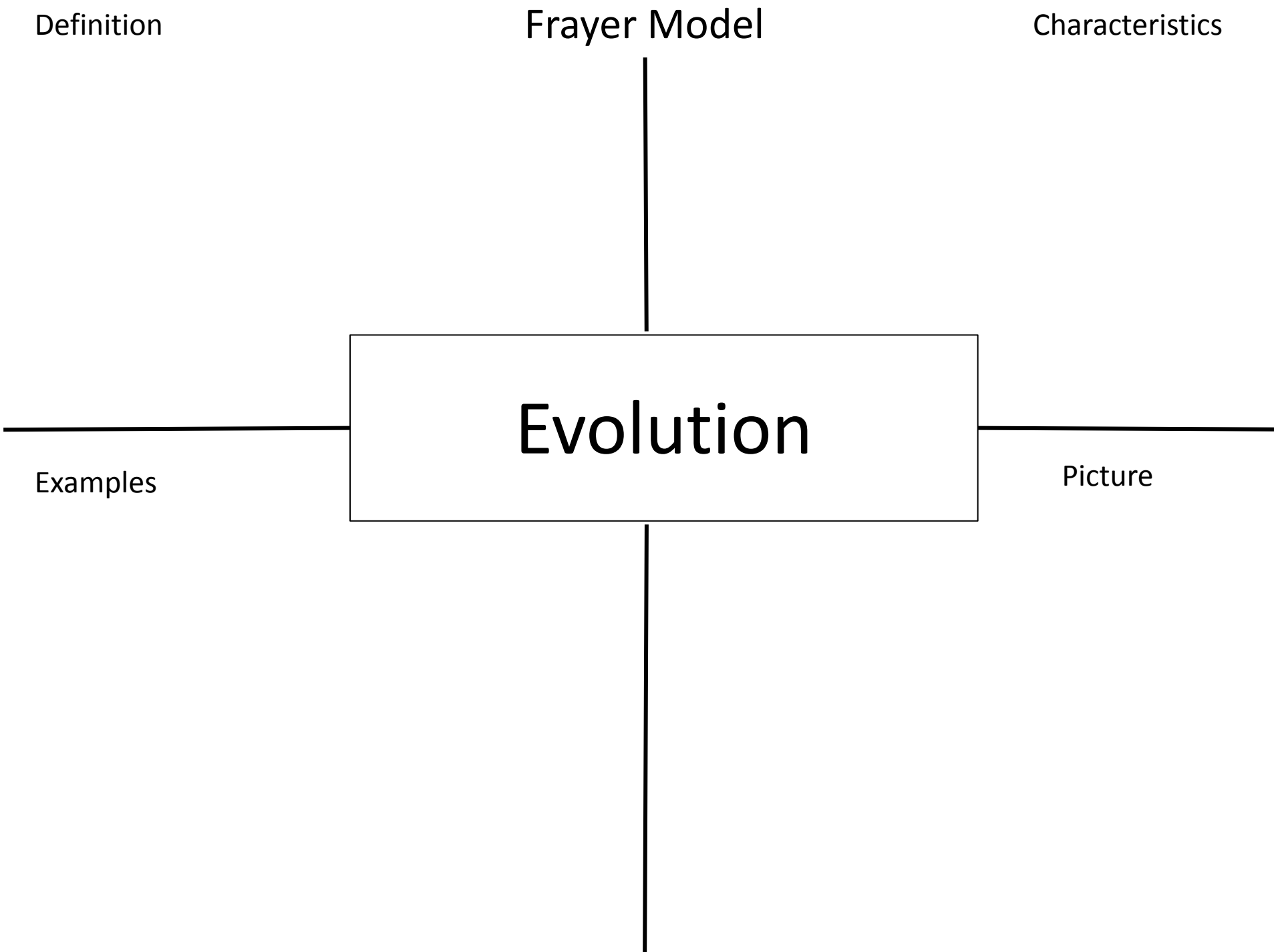
Frayer Model

Characteristics

Genetic Variation

Examples

Picture


Definition
Frayer Model
Characteristics
Evolution
Examples
Picture

Pace of Evolution

While it is generally accepted within scientific communities that evolution within a species (microevolution) is gradual and continuous, debate exists as to whether this model is true when applied across the species barrier (macroevolution)

Two opposing theories regarding the pace of evolution leading to speciation exist:

Phyletic Gradualism

- According to this model, speciation generally occurs uniformally and by the steady and gradual transformation of whole lineages
- In this view, evolution is generally seen as a smooth and continuous process

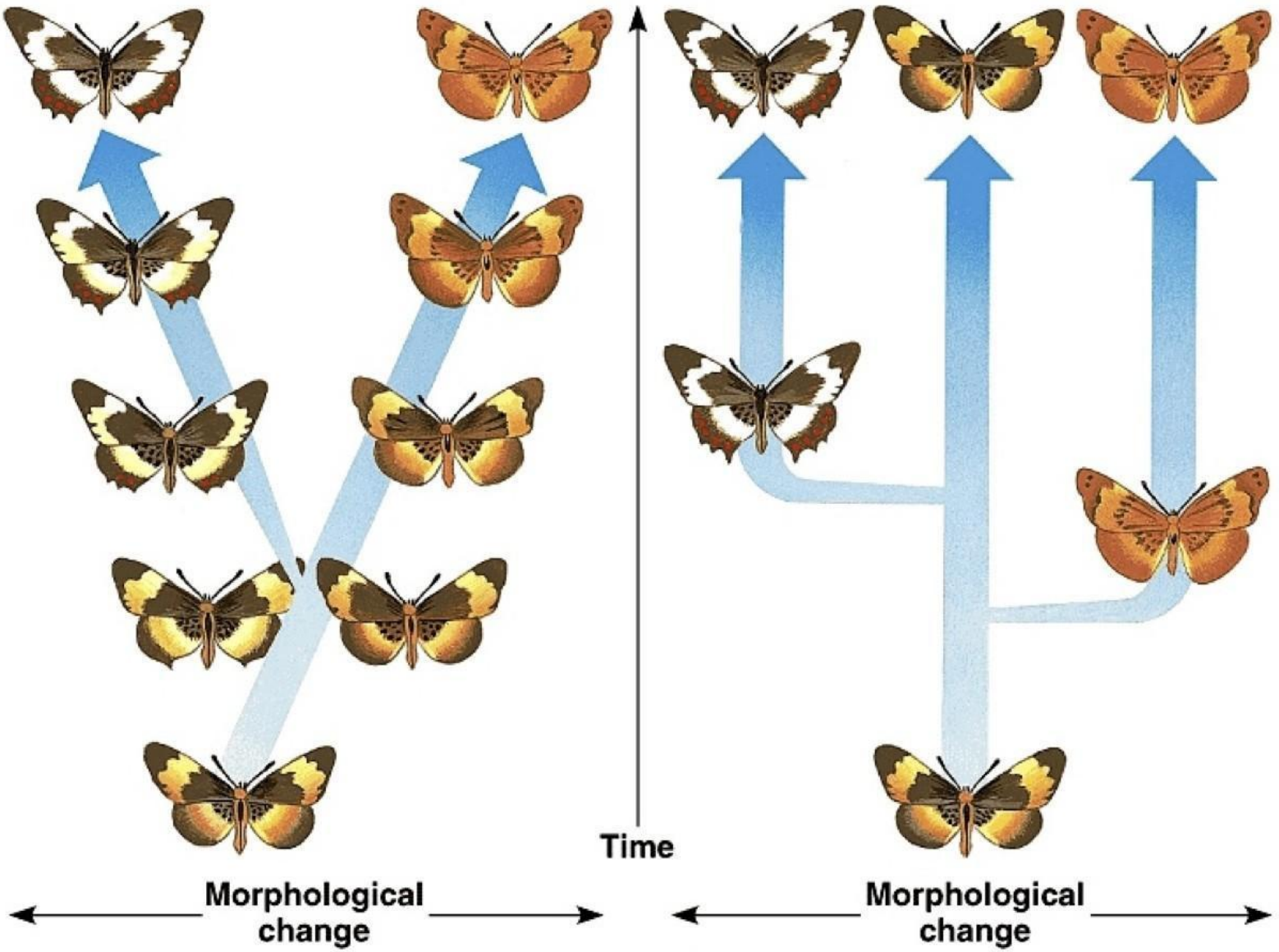
Punctuated Equilibrium

- According to this model, most sexually reproducing populations experience little change for most of their geological history
- When phenotypic evolution does occur, it is localised in rare and rapid events of branching speciation (called cladogenesis)

- *While the relative lack of transitional fossils in the fossil record would seem to support the theory of punctuated equilibrium, such an absence could also be explained due to the relatively irregular and rare conditions required for fossilisation*

Gradualism

Punctuated Equilibrium



Which method is the most believed in? Which method best follows fossil evidence?

What is natural selection?

Natural Selection

Frog and its spawn

Charles Darwin proposed that this mechanism causes species to change.

<u>These are the basic steps</u>

1. **Overproduction** of offspring.
2. **Competition** for limited resources.
3. **Survival** and **reproduction** OR death.

Natural Selection

Simulation
http://peppermoths.weebly.com/

Aa, aa

Light Form
of a Peppered Moth

aa

Dark Form
of a Peppered Moth

A process by which individuals that have favorable variations and are better adapted to their environment survive and reproduce more successfully than less well adapted individuals.

Phenotype influences genotype based on survival.

Natural Selection

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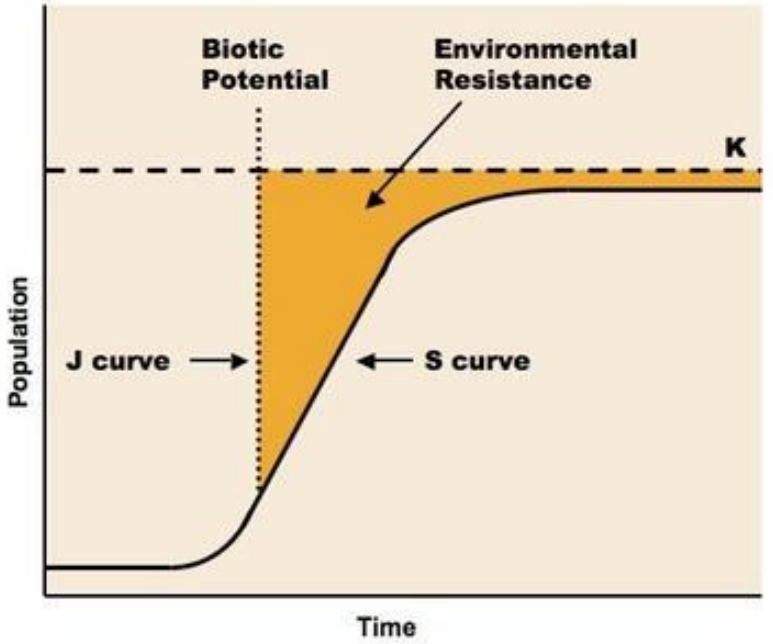
Natural Selection

2. Competition for Survival

Populations tend to produce more offspring than the environment can support



When there is an <u>abundance of resources</u>, a population can achieve a **J-curve maximum growth rate** (biotic potential)

However, with more offspring there will be less resources available to other members of the population (environmental resistance)

This will lead to competition for available resources and a **struggle for survival - 'survival of the fit'** -genes are passed to offspring

The result of this competition will be an increase in the mortality rate, leading to an **S-curve growth rate**

Natural Selection

3. Selection Pressures

Beneficial traits *(genes) are selected for,* ***weaker traits*** *are selected against.*

- **Selection pressure** are defined as external agents which affect the ability of an organism to survive.
- Selection pressures can be negative and decrease the occurrence of a trait, or beneficial and increase its proportion within a population
- Types of selection pressures include:
  - **Resource availability:** Presence of sufficient food, habitat and mates
  - **Environmental conditions:** Temperature, weather conditions or geographical access
  - **Biological factors:** Predation and disease

Natural Selection

4. Differential Reproduction

Adaptations are features of organisms that aid their survival by allowing them to be better suited to their environment

These adaptations may be categorised in a number of different ways:

Structural: Physical differences in biological structure (e.g. tail and muzzle length in cats and dogs)

Physiological: Variations in detection and responses by vital functions (e.g. homeothermy, colour blindness)

Behavioural: Differences in patterns of behaviour (e.g. certain possum species feigning death when threatened)

Developmental: Variable changes that occur across the lifespan of an organism (e.g. changes in bird plumage from juvenile to adult)

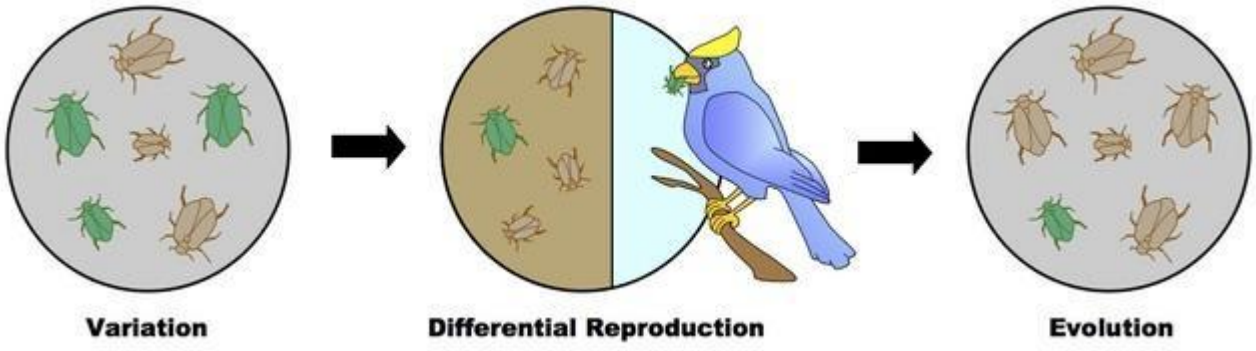
Biochemical: Differences in molecular composition of cells and enzyme functions (e.g. different blood types, skin pigmentation)

- Organisms with beneficial adaptations will be more likely to survive long enough to reproduce and pass on their genes
- Organisms without these beneficial adaptations will be less likely to survive and pass on their genes
- Darwin described this differential reproduction as ***'survival of the fittest' -*** whereby the fittest are those most capable of reproducing

Natural Selection

5. Change in Allele Frequency

- As a result of differential reproduction, features which confer a survival advantage are more likely to be passed on to subsequent generations
- Over time, this will change the relative proportions of an allele (and hence the genetic composition) within a given population
- As the viability of a particular feature was determined by naturally-occurring selective agents, this process is described as natural selection



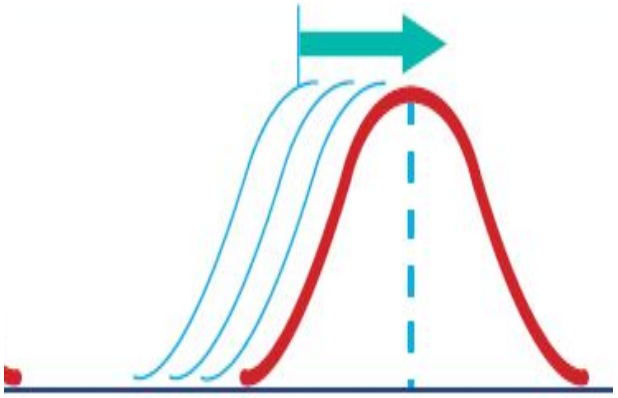
Summary of Natural Selection

1. There is genetic variation within a population (which can be inherited)
2. There is competition for survival (populations tend to produce more offspring than the environment can support)
3. Environmental selective pressures lead to differential reproduction
4. Organisms with beneficial adaptations will be more suited to their environment and more likely to survive to reproduce and pass on their genes
5. Over generations there will be a change in allele frequency within a population (evolution)

Natural selection can affect the frequency of phenotypes in a population depending on which phenotype is favorable.

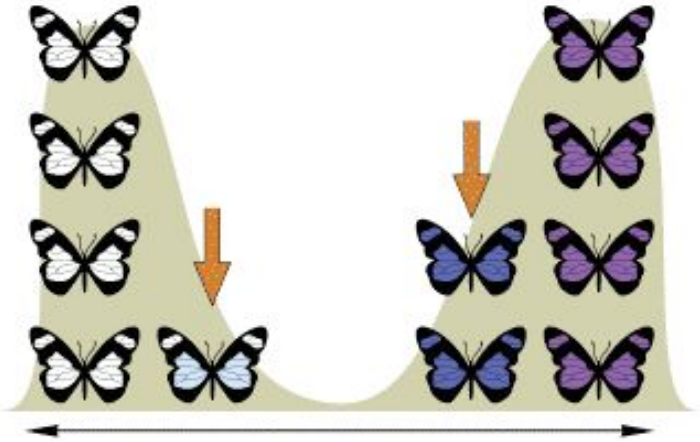
These are the three types of SELECTION.

Directional

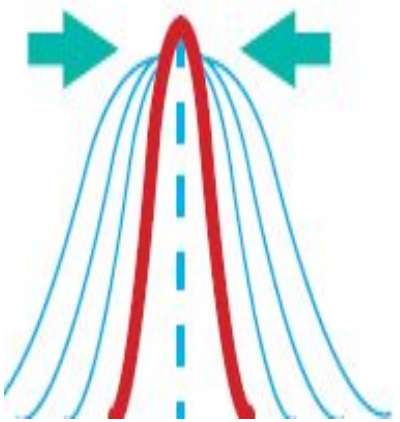


Selected for?

Disruptive



Stabilizing



Selected against?

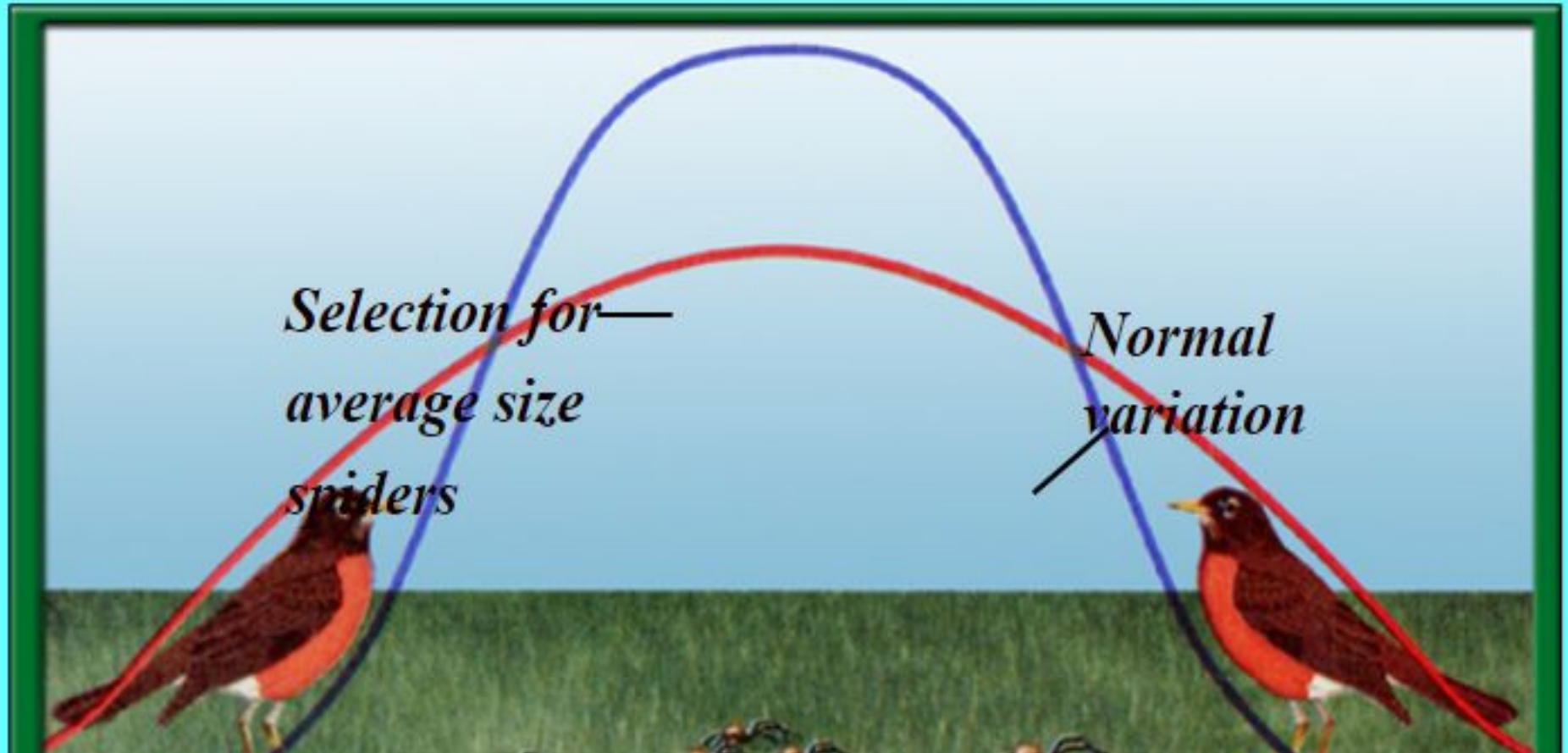
Phenotype is selected against /selected for – changing the population of alleles

Forms of Selection

- Selection is a statistical concept
  - One cannot predict the fate of any single individual
  - But it is possible to predict which kind of individual will tend to become more common in a population
- Three types of natural selection have been identified
  - Stabilizing selection
    - Acts to eliminate *both* extreme phenotypes
  - Disruptive selection
    - Acts to eliminate intermediate phenotypes
  - Directional selection
    - Acts to eliminate a *single* extreme phenotype

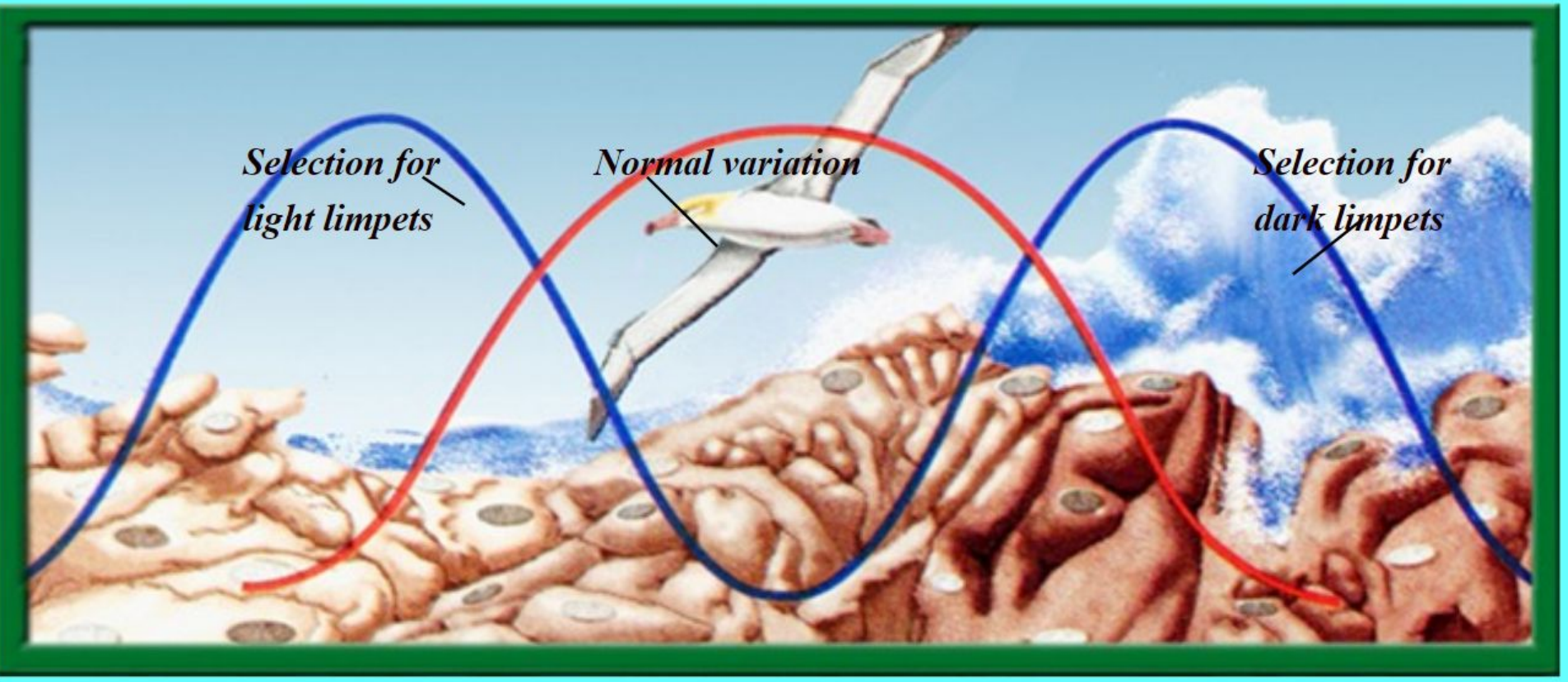
Natural selection acts on variations

- Stabilizing selection is a natural selection that favors average individuals in a population.



Natural selection acts on variations

- In disruptive selection, individuals with either extreme of a trait's variation are selected for.



Natural selection acts on variations

- Directional selection occurs when natural selection favors one of the extreme variations of a trait.