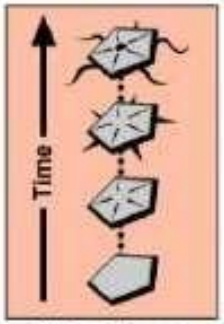
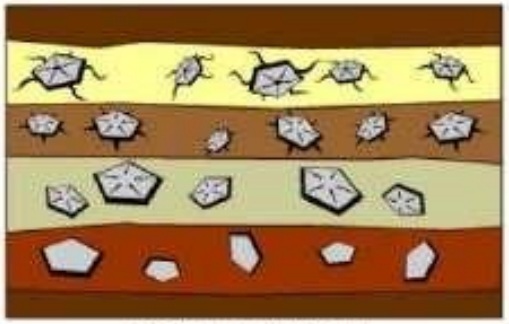
# Evidence for Evolution

## Fossil record

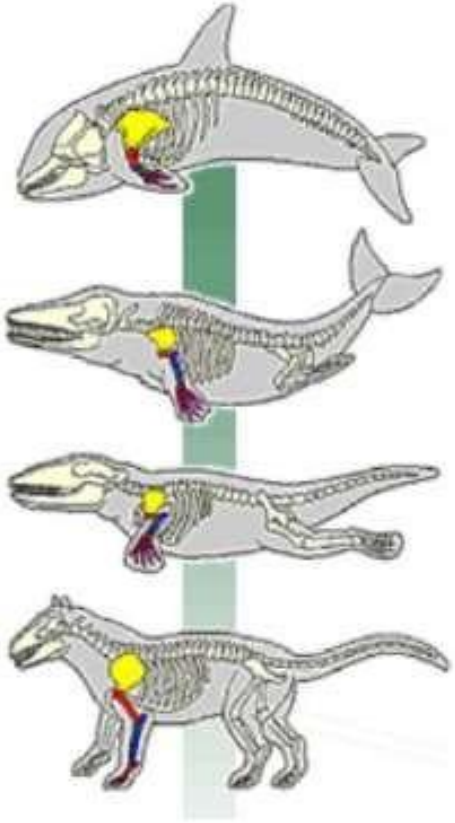



Gradual lineage evolution



Rock strata with fossils

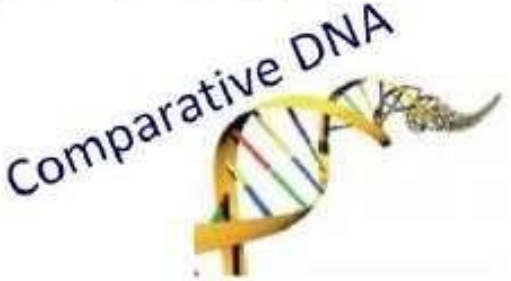
## Homologous structures



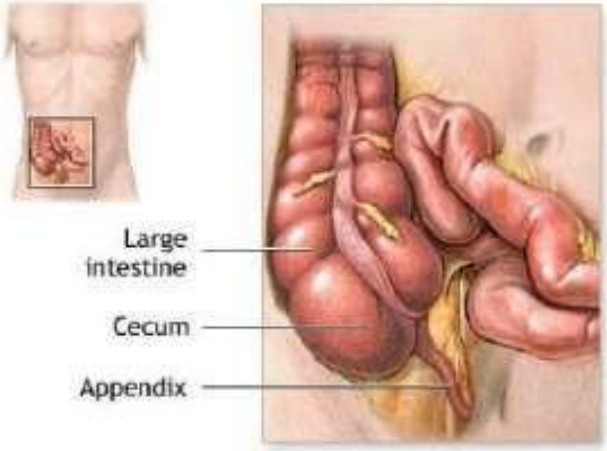
http://evolution.berkeley.edu/evosite/evo101/VIIAPaceevolution.shtml

## Selective breeding

http://www.bbc.co.uk/schools/ks3bitesize/science/images/bio_dogs.gif

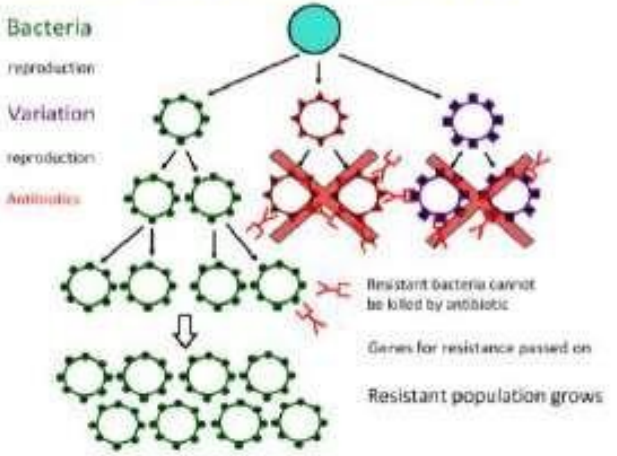



## Vestigial structures

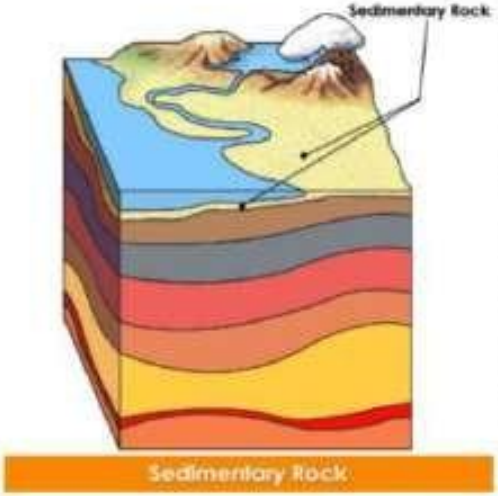



http://www.nlm.nih.gov/MEDLINEPLUS/ency/imagepages/1128.htm

## Observable changes

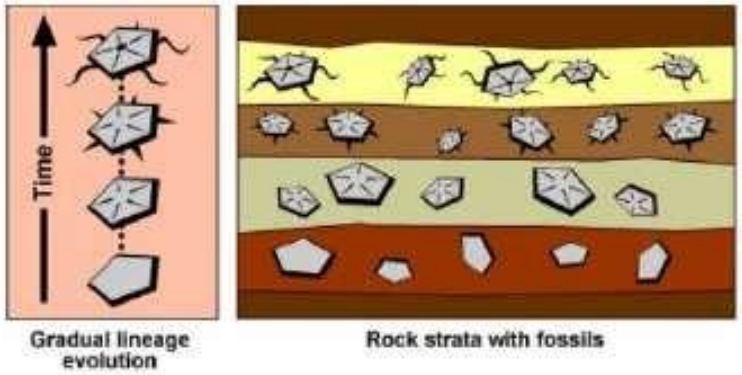


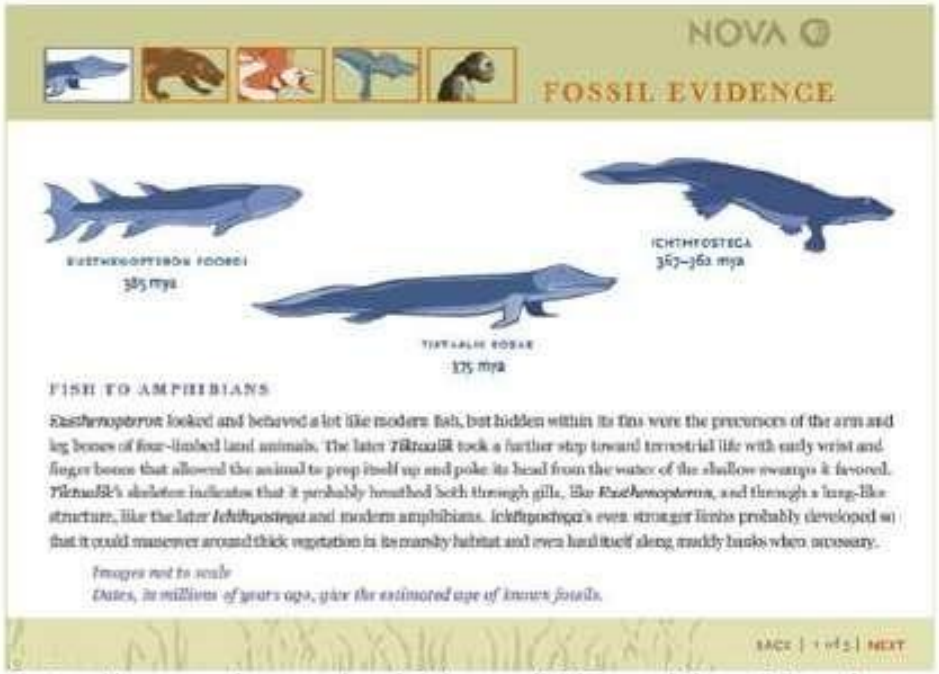
# The Fossil Record




As layers of sedimentary rock are put down, the inorganic components of plants, animals and prokaryotes are preserved. Simply put, the deeper they are, the older they are.

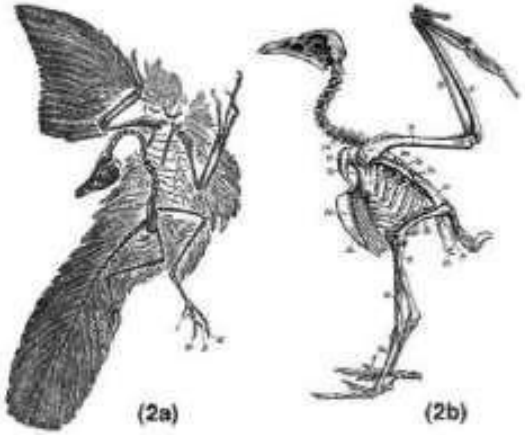
These fossils show a transition over time that echoes the development of species through the theory of evolution.




http://www.pbs.org/wgbh/nova/id/transitional.html

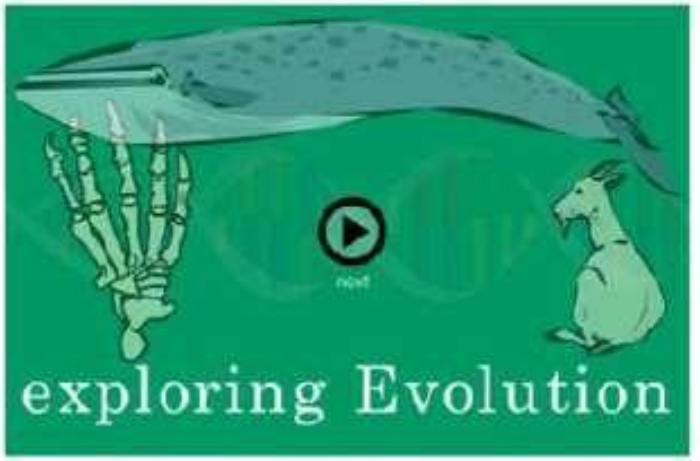
Some fossils, such as the famous *Archaeopteryx lithographica*, represent transition species:



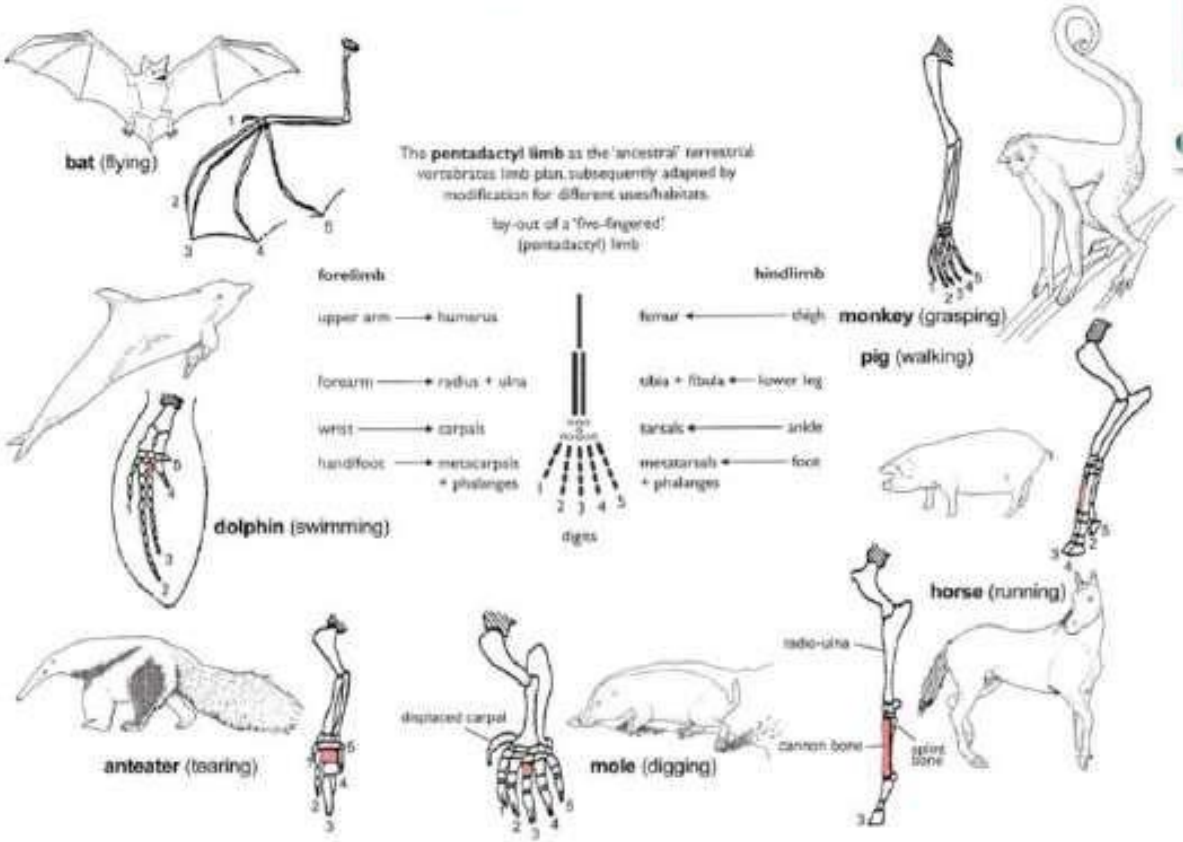

*Archaopteryx lithographica*

# Homologous Structures

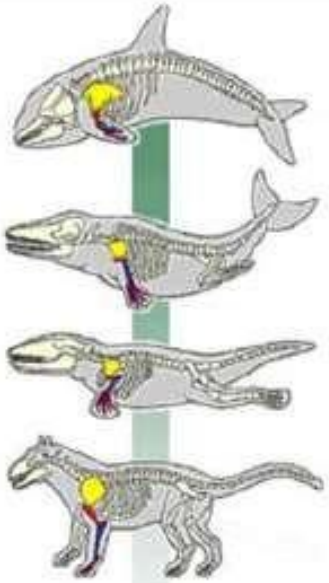
Darwin noticed many similarities in the structures of different species: parts of the body (such as the pentadactyl limb) which had been adapted for different functions. This is evidence of common ancestry and shows adaptive radiation.




http://www2.edc.org/weblabs/ExploringEvolution/evolution.swf




http://en.wikipedia.org/wiki/Image:Evolution_pl.png



evolution of the whale

http://evolution.berkeley.edu/evosite/evo101/VIIAPaceevolution.shtml

# Evolution: The cumulative change in the heritable characteristics of a population.

cumulative change: small changes upon small changes over many generations

heritable characteristics: gene-controlled factors

population: not an individual

# Peppered Moth Melanism:evolution in action

Peppered moth (*Biston betularia*)

Selection pressure: predation by birds


http://www.techapps.net/interactives/pepperMoths.swf

## Variation:

**White phenotype (*typica*)**
common before industrial revolution
camouflaged against white lichen on trees

**Black phenotype (*carbonaria*)**
common after industrial revolution
camouflaged against black soot

Environmental change: sooty pollution from factories

Result: *typica* stands out against soot-covered trees
*carbonaria* is camouflaged by black soot

typica population declines due to predation
carbonaria population increases

This has reversed again with clean air policies.

Play another one here:
Virtual Peppered Moths

http://www6.district125.k12.il.us/~nfischer/Moth/

''.....can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving and procreating their kind? On the other hand, we may feel sure that any variation in the least injurious would be rigidly destroyed. This preservation of favourable variations and the rejection of injurious variations, I call Natural Selection'

**Darwin C. (1859)** *The Origin of Species*

http://www.biology.ed.ac.uk/public/images/c_darwin.jpg

There is variation between members of a species.

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A result of

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There is variation between members of a species.

A result of

Random Mutation

DNA replication

viral infection

https://www.biology.ed.ac.uk/public/images/c_darwin.jpg

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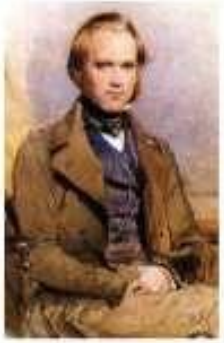
A result of

Random Mutation

Sexual Reproduction

DNA replication

viral infection



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meiosis

crossing over
(recombination)
prophase I

random assortment
of chromosomes
metaphase I

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Sexual Reproduction

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random assortment of chromosomes metaphase I

random fertilisation

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## Mutations that give an advantage are selected for.

The individual which can best compete in the struggle for survival
will survive long enough to reproduce - and pass on the trait.

## Mutations that give a disadvantage are selected against.

A mutation or trait that means an individual is
less well suited to the environment will make it
more difficult for the individual to survive.
The individual is less likely to pass on the trait.

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Populations tend to produce more offspring than the environment can support.

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⇩

Struggle for Survival

(*Nature red in tooth and claw**)

*who wrote that?

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Struggle for Survival ⟵ Competition for Food

- finding
- reaching
- catching
- opening
- digesting

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Struggle for Survival

Competition for Food

- finding
- reaching
- catching
- opening
- digesting

Predation

- catching
- fighting
- avoiding
- escaping

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## Struggle for Survival

### Competition for Food
- finding
- reaching
- catching
- opening
- digesting

### Predation
- catching
- fighting
- avoiding
- escaping

### Parasitism
- invading
- avoiding
- removing
- tolerating

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## Struggle for Survival

Competition for Food
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- reaching
- catching
- opening
- digesting

Predation
- catching
- fighting
- avoiding
- escaping

Parasitism
- invading
- avoiding
- removing
- tolerating

Disease
- invading
- avoiding
- removing
- tolerating

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- digesting

### Predation
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- escaping

### Parasitism
- invading
- avoiding
- removing
- tolerating

### Disease
- invading
- avoiding
- removing
- tolerating

### Competition for Mates
- attracting
- fighting
- selecting
- fertilising
- providing for

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## Struggle for Survival

### Competition for Food
- finding
- reaching
- catching
- opening
- digesting

### Competition for Space
- living space/shelter
- nesting space
- reproductive space

### Predation
- catching
- fighting
- avoiding
- escaping

### Parasitism
- invading
- avoiding
- removing
- tolerating

### Disease
- invading
- avoiding
- removing
- tolerating

### Competition for Mates
- attracting
- fighting
- selecting
- fertilising
- providing for

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Variation within populations

Variation can be inherited

Populations produce more offspring than environment can support

or

Environment changes

Struggle for survival
(selection pressures)

Disdvantageous variations selected against (die)

Less likely to reproduce & pass on genes

Frequency of genes decreases

Advantageous variations selected for (survive)

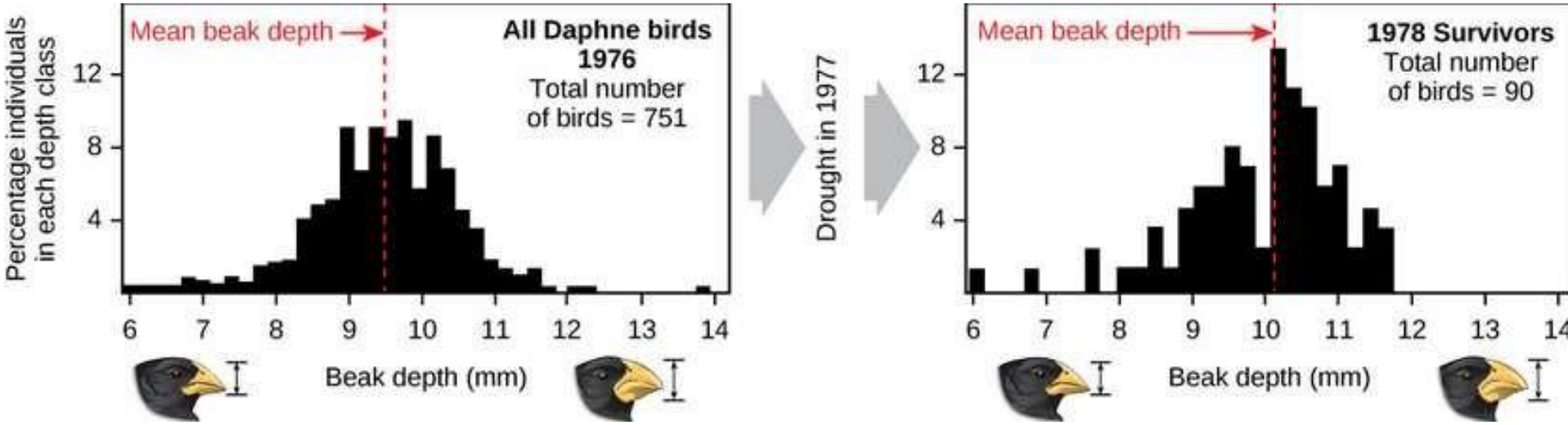
More likely to reproduce & pass on genes

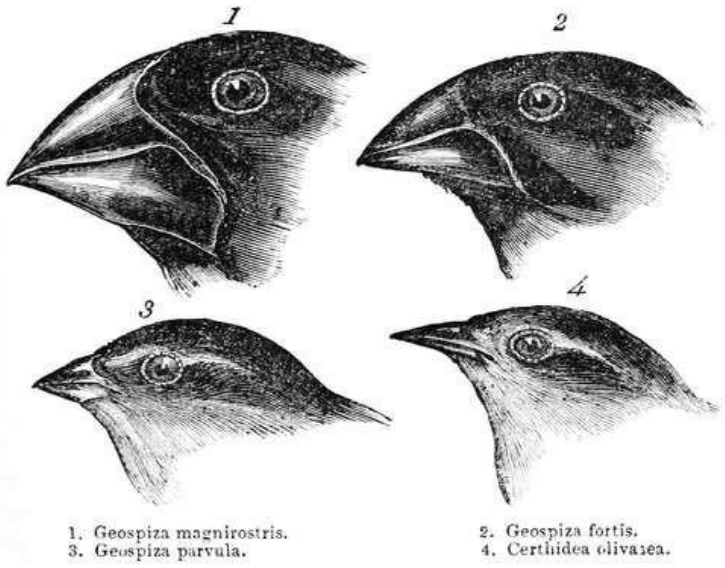
Gene frequency increases

Population evolves to be adapted to the environment

**Natural Selection**

# The Finches of Daphne Major



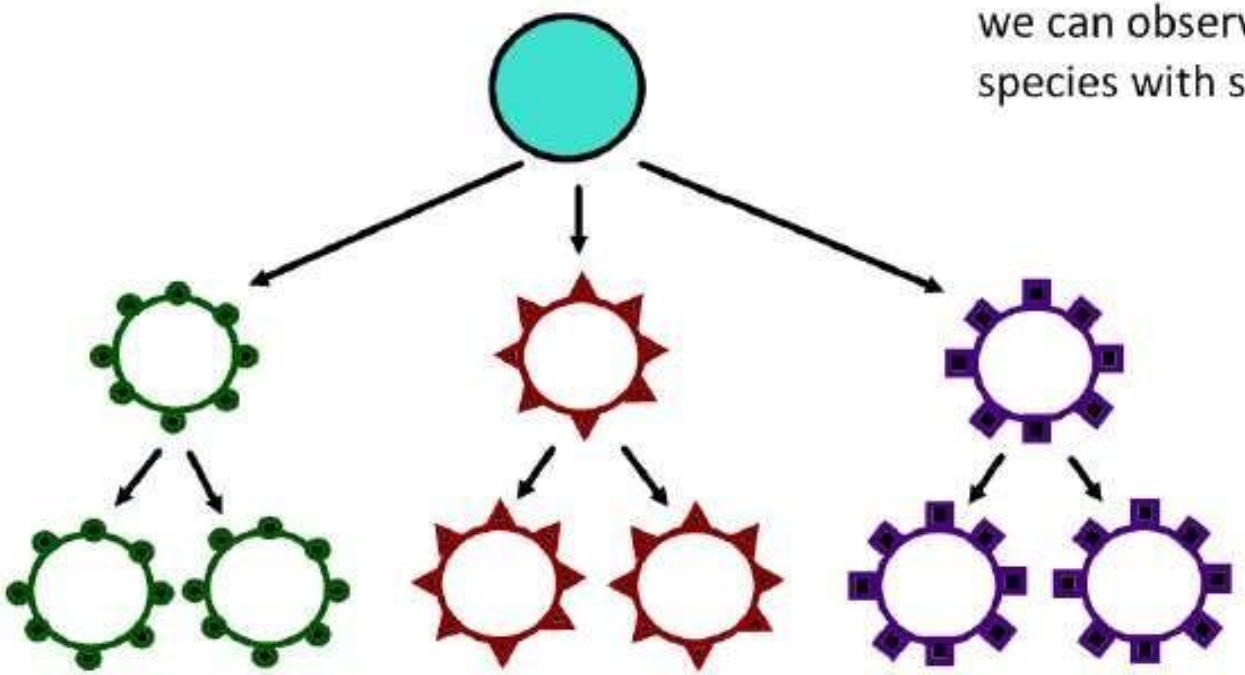

we can observe evolution in species with short life-cycles

Bacteria

reproduction

Variation

reproduction



we can observe evolution in species with short life-cycles

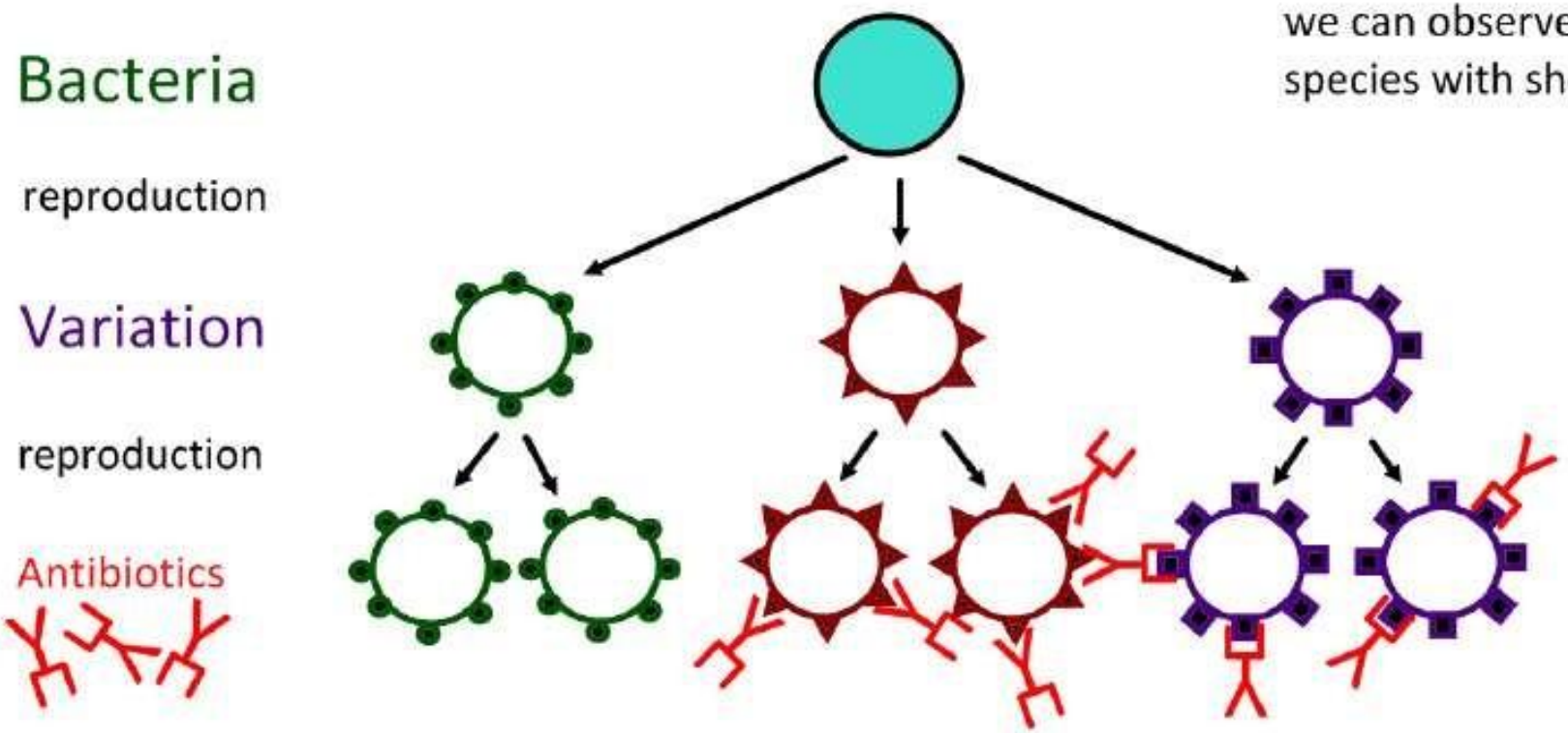
Bacteria

reproduction

Variation

reproduction

Antibiotics



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Bacteria

reproduction

Variation

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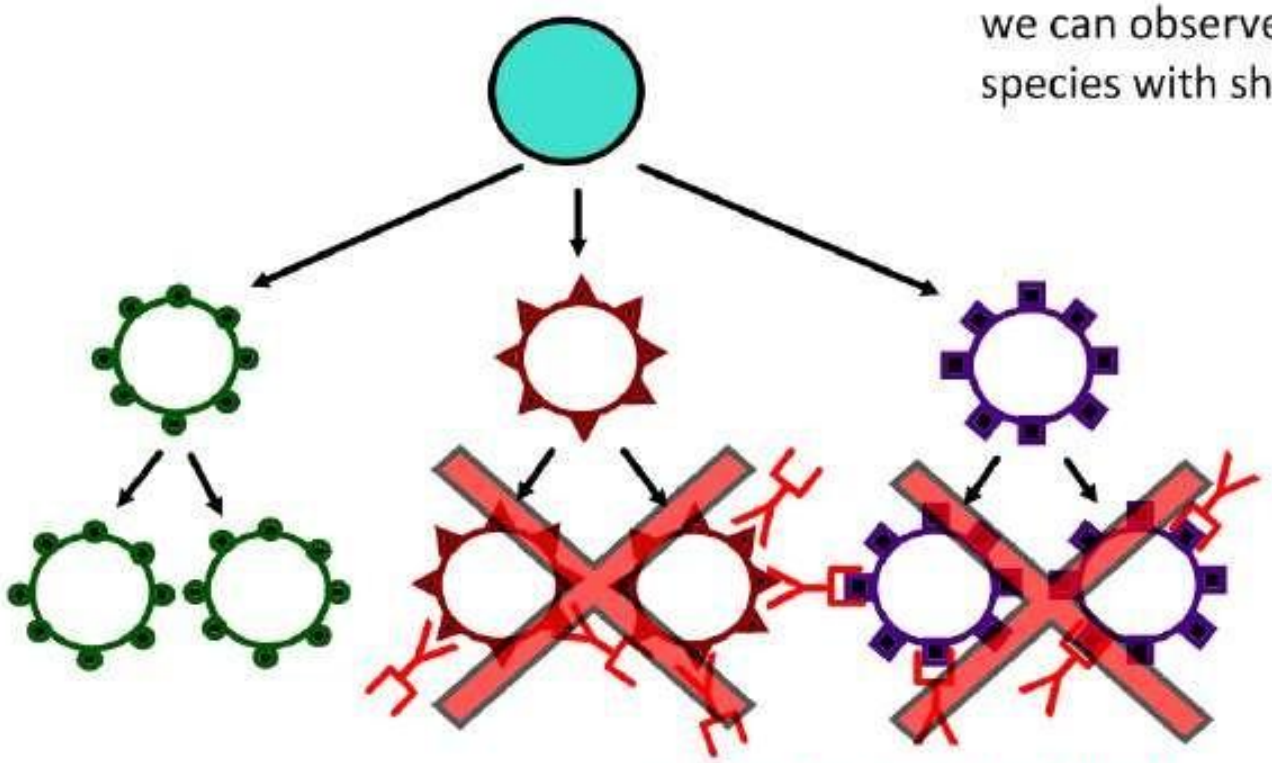


resistant strain survives

non-resistant strains killed

we can observe evolution in species with short life-cycles

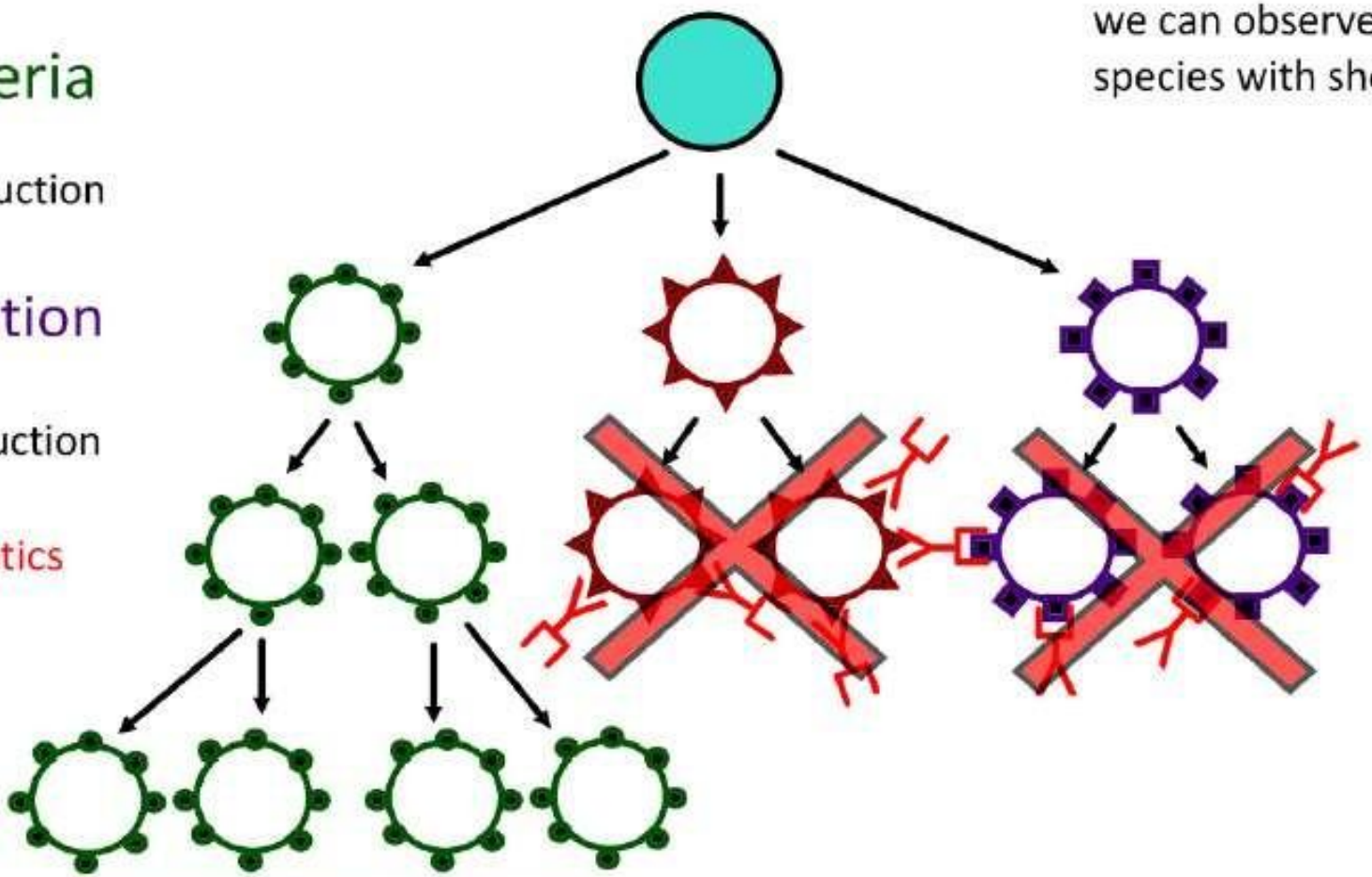
Bacteria

reproduction

Variation

reproduction

Antibiotics



resistant strain reproduces

we can observe evolution in species with short life-cycles

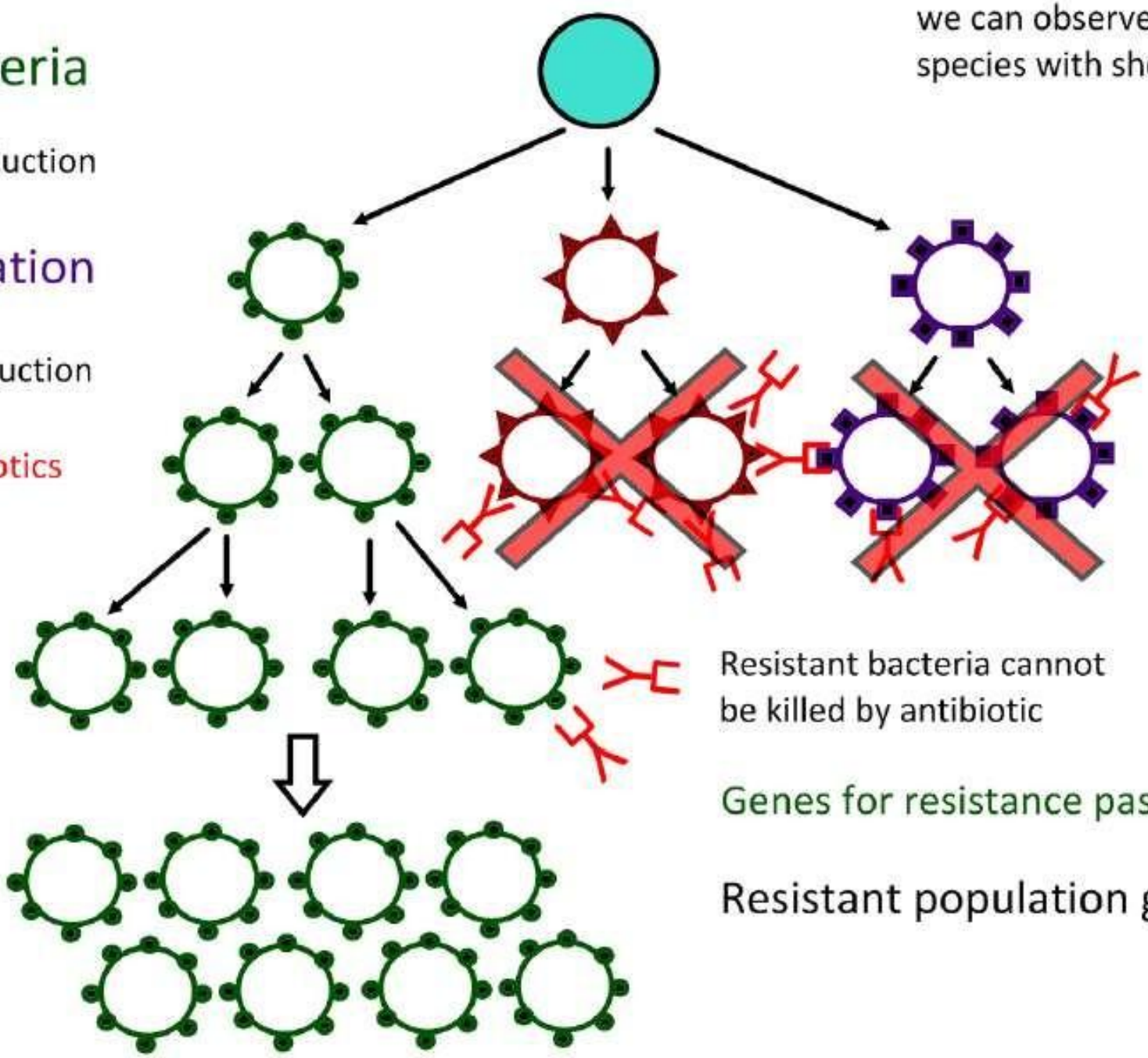
Bacteria

reproduction

Variation

reproduction

Antibiotics



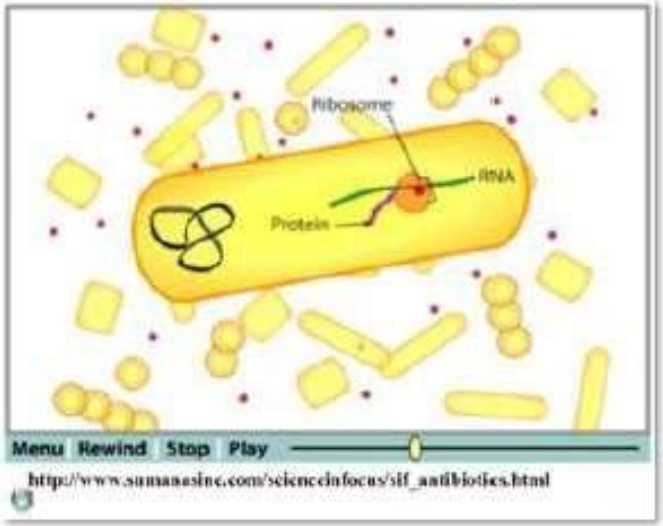
Resistant bacteria cannot be killed by antibiotic

Genes for resistance passed on

Resistant population grows

# Antibiotic Resistance: evolution in action

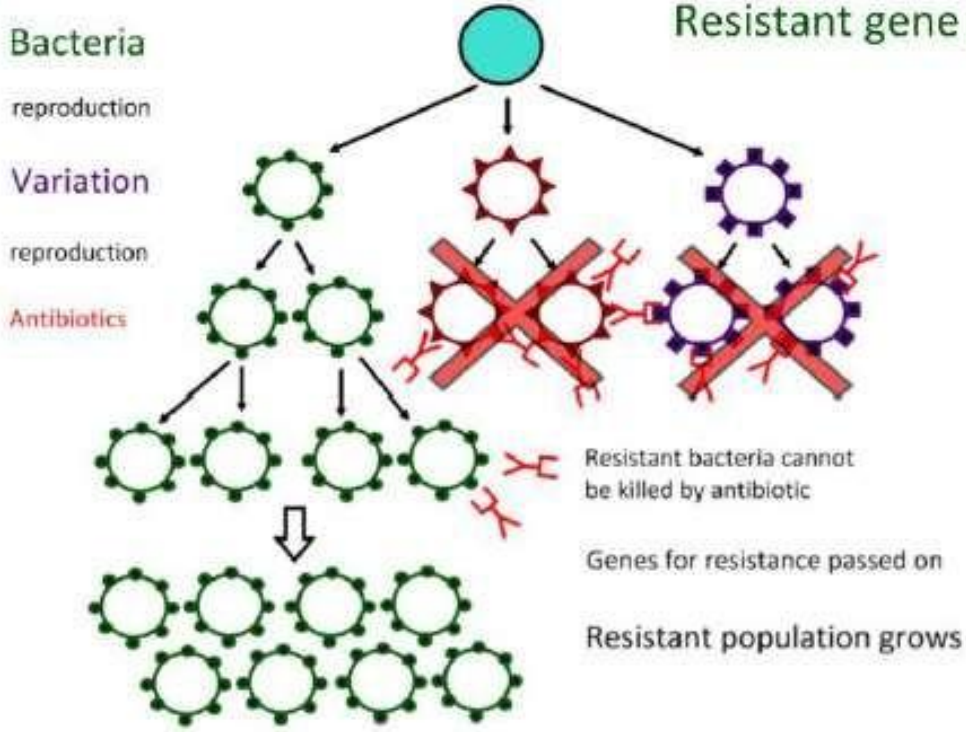
*Staphyloccoccus aureus* - bacteria




Variation: Methycillin-*resistant* (MRSA)
Methycillin-*susceptible* (MSSA)

Environmental change: application of methycillin

Result: MSSA is killed
MRSA survives
MRSA reproduces
Resistant gene proliferates


MRSA population increases

MRSA is dominant strain

Methycillin is no longer effective against infection

# Bibliography / Acknowledgments

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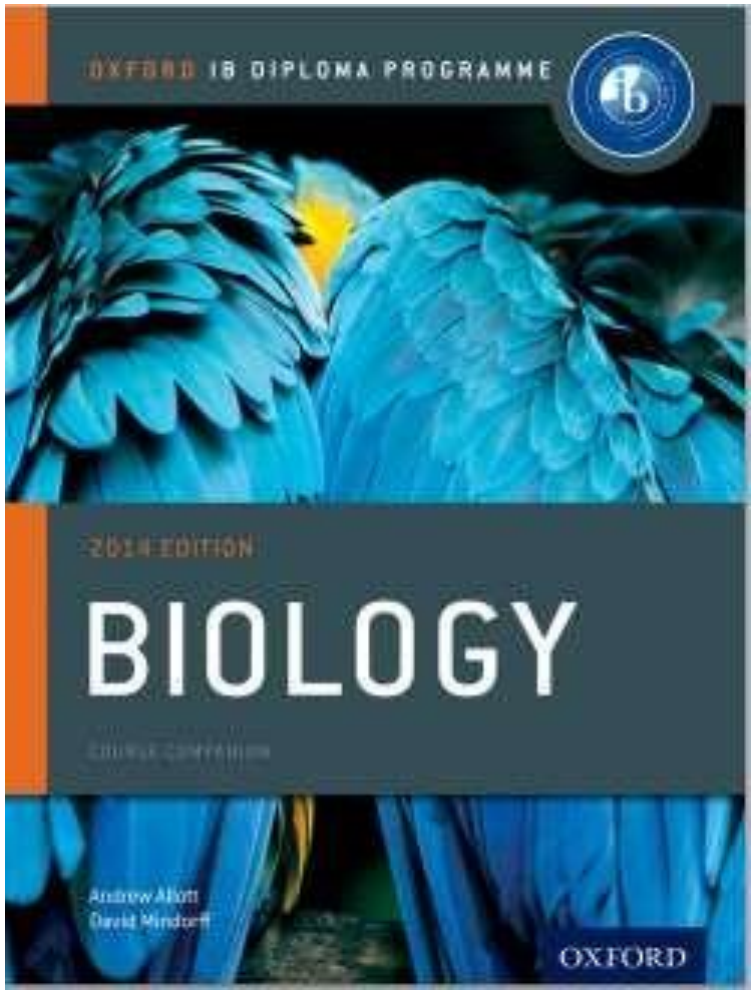


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Jason de Nys

Chris Paine