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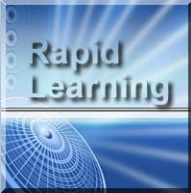



Rapid Learning Center Presenting ...

Teach Yourself
Evolution and Ecology in 24 Hours



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**Introduction to
Evolutionary Thought**

Rapid Learning Tutorial Series

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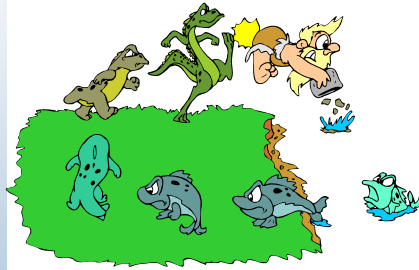
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Learning Objectives

By completing this tutorial, you will learn about ...



- The definition of evolutionary biology
- Pre-Darwinian history of evolutionary thought
- Darwinian evolution
- The modern evolutionary synthesis
- Basic principles of genetics

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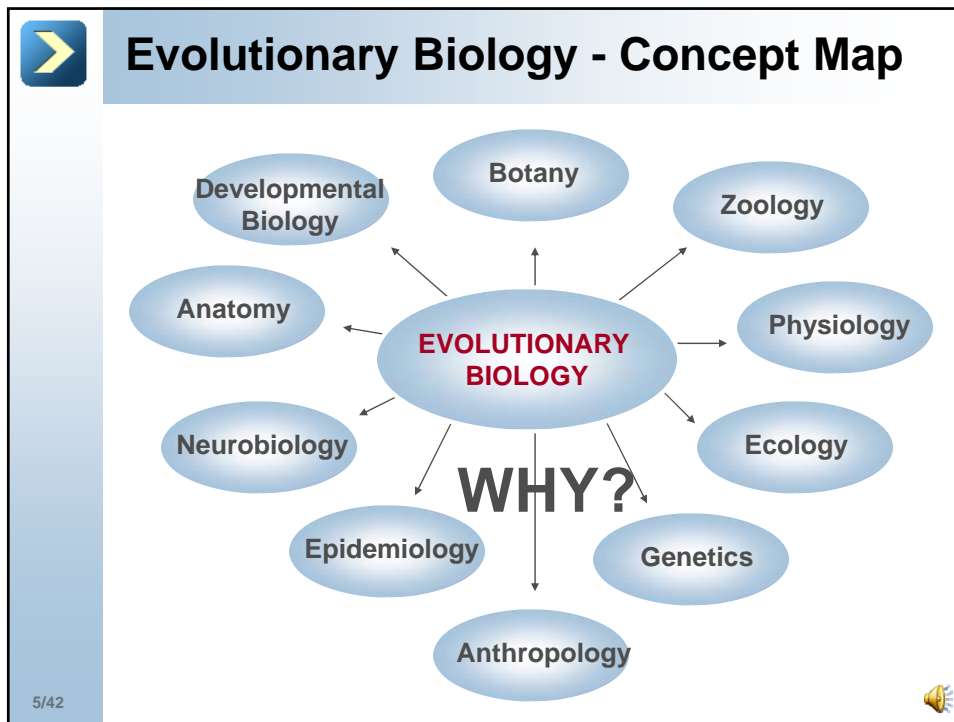
Quotation

**“Nothing in biology makes sense
except in the light of evolution”**



— Theodosius Dobzhansky,
American Biology Teacher, 35: 125-129

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Evolutionary Biology Defined






1. Definition
2. Who studies evolutionary biology

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> Definition

Evolutionary Biology


- An interdisciplinary area of biology that studies the history of life on Earth

- Concerned with the origin, descent, distribution, and changes in species over time – macroevolution
- Concerned with the origin, descent, distribution, and changes in allele/gene frequencies over time – microevolution

Evolution



- Descent (through genetic inheritance) with modification


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> Who Studies Evolutionary Biology - 1

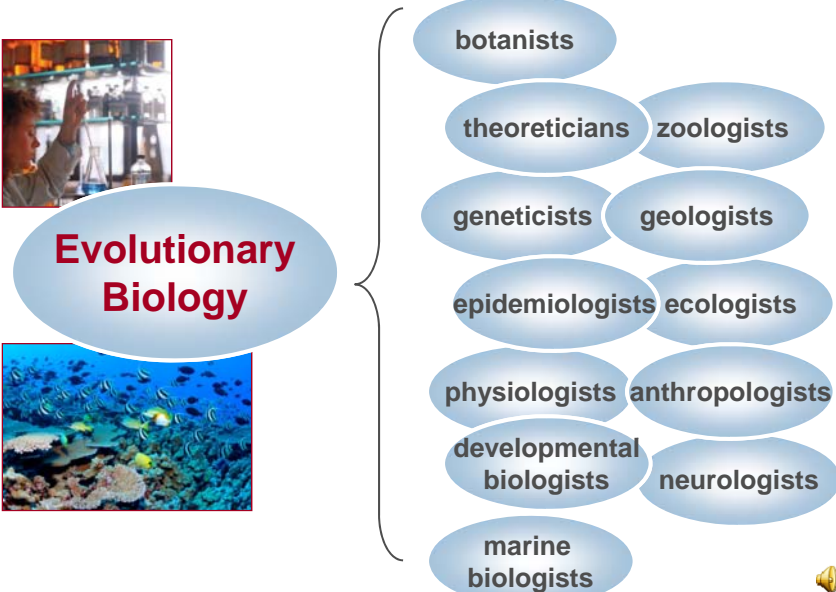
Evolutionary Biology

Interdisciplinary – studied by many types of biologists

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Who Studies Evolutionary Biology - 2




Evolutionary Biology

- botanists
- theoreticians
- zoologists
- geneticists
- geologists
- epidemiologists
- ecologists
- physiologists
- anthropologists
- developmental biologists
- neurologists
- marine biologists

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Pre-Darwinian History of Evolutionary Thought



1. Early theories of evolution
2. Lamarckism

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Early Theories of Evolution - 1

Great Chain of Being or Scala Naturae

- Most widely accepted early evolutionary theory in Western society
- Form of classification that was strictly hierarchical
- Organisms could not move from there place in the hierarchy
- Earth and minerals formed the basis followed by plants, animals, man, angels, and God
- Influenced Carolus Linnaeus' taxonomic system – still used today
- Widely accepted until Darwin's time



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Early Theories of Evolution - 2

Lamarckism

One of the most notable evolutionists prior to Darwin was **Lamarck**, who developed the now discredited theory of the...



**Jean-Baptiste
Lamarck**

**Inheritance of
Acquired
Characteristics**

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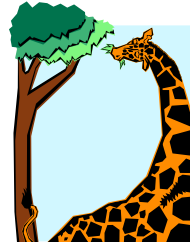




Lamarckism

Inheritance of acquired characteristics

- Individuals acquire characters they require and lose characters they do not use – **use and disuse**
- Characters are inherited by offspring – mechanism unknown
- Results in the development of higher forms – suggesting that evolution is a directed process
- Theory was discredited by the modern evolutionary synthesis when mechanisms of inheritance were better understood



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Lamarckism




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Darwinian Evolution

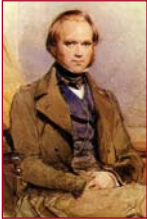


1. Charles Darwin
2. Darwin's theory of natural selection
3. An example: antibiotic resistance

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Charles Darwin - 1




- “Father” of modern evolutionary biology
- Studied to be a clergyman at **Cambridge University**
- Excelled at **natural history**

- Invited on expedition to chart South American coastline aboard the **HMS Beagle**
 - Made observations that formed the basis of his **Theory of Natural Selection**
 - Galapagos' **finches** and **tortoises**
 - Read Lyell's "**Principles of Geology**" – gradual change over time




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➤ Charles Darwin - 2



Struggle
for
Existence

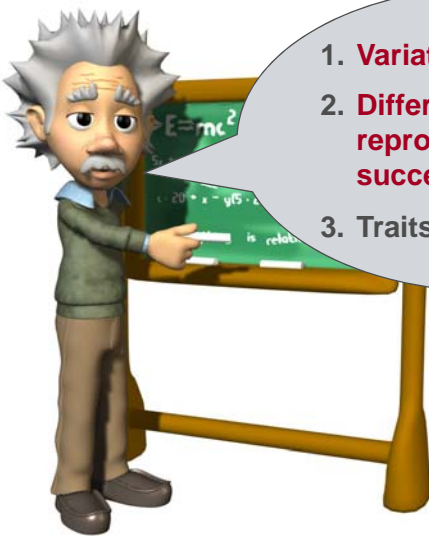
- Studied **Thomas Malthus**' theory, which suggested that population growth is limited by available resources
- Individuals with the "best" traits will survive the struggle
- Studied animal breeding methods – notably pigeon breeders
 - Breeders choose the most desirable traits and reproduce those individuals – **artificial selection**
- Publication of "**On the Origin of Species**" in 1859 that outlined the **Theory of Natural Selection**



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➤ Theory of Natural Selection - 1

Principles of the theory

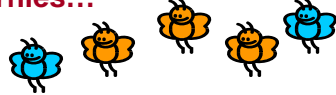


1. **Variation** in traits
2. **Differential reproductive success**
3. Traits are **heritable**



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➤ Theory of Natural Selection - 2

Imagine a population of butterflies...



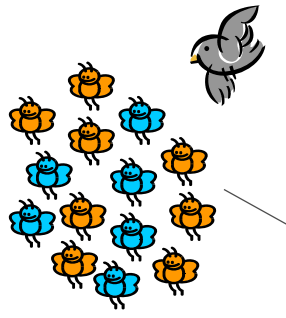
Variation in traits	➔	Blue and orange butterflies
Differential reproductive success	➔	Blue butterflies are more likely to be eaten by birds and thus less likely to reproduce
Traits are heritable	➔	Surviving orange butterflies have more orange offspring
RESULT	➔	More advantageous trait , orange coloration, becomes more common in the population each generation


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➤ Theory of Natural Selection - 3

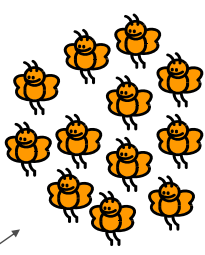
1. **Variation** in traits
2. **Differential reproductive success**
3. Traits are **heritable**




Coloration



Orange butterflies survive and reproduce



Orange butterflies have orange offspring



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▶ An Example of Natural Selection

Antibiotic Resistance

- Antibiotics are used to treat bacterial infections
- Some bacteria carry genes making them resistant to antibiotics – **variation & heritability**
- Resistant bacteria survive, reproduce, and populate the next generation, resulting in a resistant strain of bacteria – **differential reproductive success**
- Antibiotic is no longer effective at treating this bacteria

● Normal bacteria
● Resistant bacteria

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The Modern Evolutionary Synthesis


1. Definition
2. Natural selection + genetics
3. Mendelian genetics and beyond

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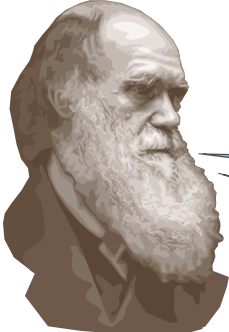
Definition

Modern Evolutionary Synthesis – The combination of Darwin’s **Theory of Natural Selection** with Mendel’s **Theory of Genetics** and subsequent genetic studies



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Natural Selection + Genetics




- **Variation** in traits
- **Differential reproductive success**
- Traits are **heritable**

How does variation arise?

How are traits passed from parent to offspring?

MODERN EVOLUTIONARY SYNTHESIS

- **Variation** in traits arises by chance through genetic mutations
- Traits are **inherited** by offspring from parents on genes located on chromosomes

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Mendelian Genetics and Beyond

1st half of the 20th century

Mendel's

work with peas was rediscovered and explained the **heritability** of traits

T.H. Morgan's

work with *Drosophila* mutants confirmed Mendel's observations of **inheritance**

R.A. Fisher

derived a statistical model to explain Mendelian inheritance - **population genetics**

T. Dobzhansky's

work with natural populations of *Drosophila* resulted in a book entitled "Genetics and the Origin of Species" where he **integrated Mendelian genetics, population genetics, and natural selection**

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Basic Principles of Genetics

1. Basic genetic structures
2. Punnett squares
3. Mendelian inheritance

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➤ Basic Genetic Structures

- 1 **Chromosomes** contain all of the genetic information of an organism
- 2 **Diploid** organisms have two copies of each chromosome
- 3 A **locus** (loci) is the location of a gene on a chromosome
- 4 A **gene** is portions of chromosomes that code for a particular trait
- 5 An **allele** is a version of a particular gene

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➤ Punnett Squares

Punnett squares help determine offspring genotypes from a cross between two individuals

- **Genotype** – allelic make-up of a trait
- **Phenotype** – observable expression of genotype
- **Homozygous** – having two copies of the same allele at a locus
- **Heterozygous** – having two different alleles at a locus
- **Dominant** – in heterozygotes, the allele that is expressed in the phenotype
- **Recessive** – in heterozygotes, the allele that is not expressed in the phenotype

A and a


A A	A a	a a
↓	↓	↓
big	big	small

	A	A
a	Aa	Aa
a	Aa	Aa


🔊

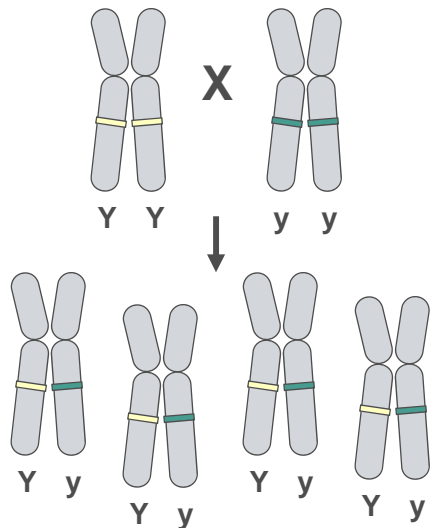
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➤ Mendelian Inheritance - 1




- Law of **dominance**
- Law of **segregation**
- Law of **independent assortment**






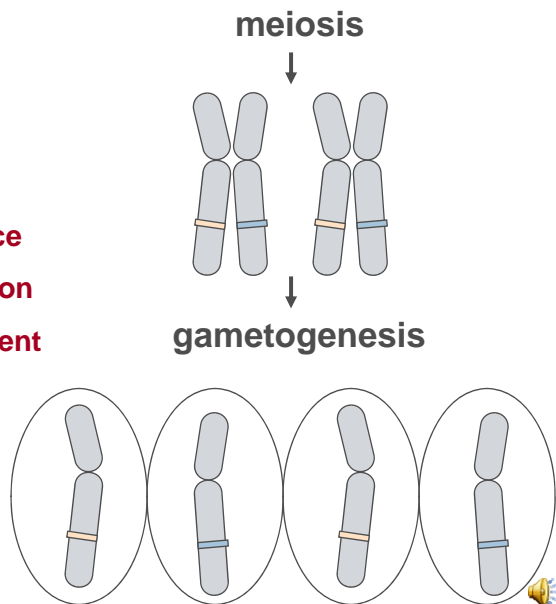
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➤ Mendelian Inheritance - 2




- Law of **dominance**
- Law of **segregation**
- Law of **independent assortment**



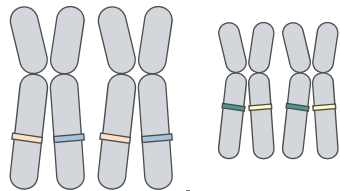


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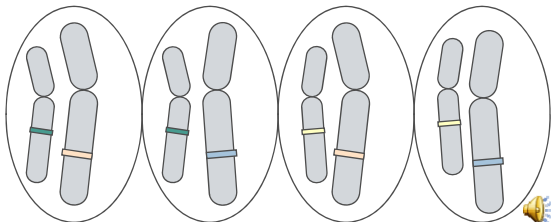
Mendelian Inheritance - 3




meiosis



gametogenesis

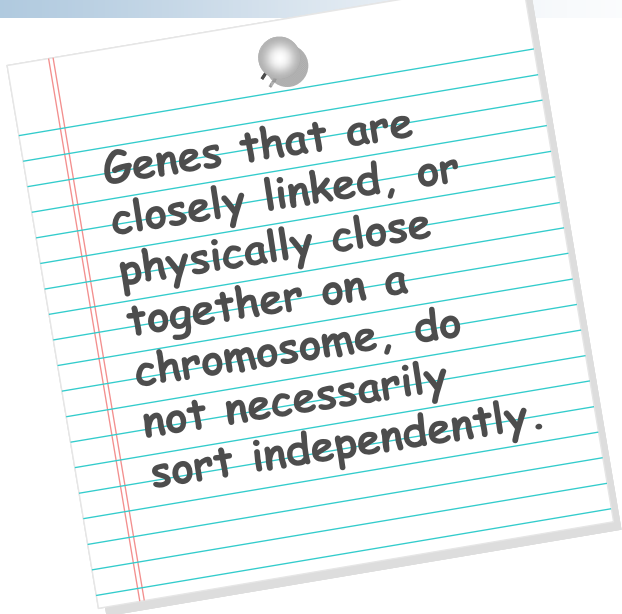


- Law of **dominance**
- Law of **segregation**
- Law of **independent assortment**




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Note – Independent Assortment





Genes that are closely linked, or physically close together on a chromosome, do not necessarily sort independently.

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Stop-and-Think Activities



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?

Question: Punnett Squares

Complete the Punnett Square and answer the following questions.

	T	t
T	1	2
T	3	4

1 _____

2 _____

3 _____

4 _____


5 _____

6 _____

T = tall **t** = short

5 How many offspring are heterozygous?

6 How many offspring are tall?

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Answer: Punnett Squares

Complete the Punnett Square and answer the following questions.

	T	t
T	①	②
T	③	④

T = tall **t** = short

- ⑤ How many offspring are heterozygous?
 ⑥ How many offspring are tall?

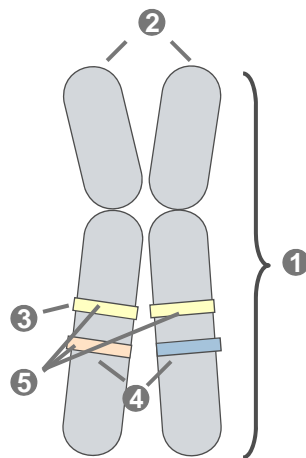
- ① TT
 ② Tt
 ③ TT
 ④ Tt
 ⑤ two
 ⑥ four

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Question: Chromosome Structure

Fill in the blanks with the correct term, choosing from the following terms: *gene*, *locus*, *alleles*, *chromosome pair*, *chromosome*.



- ① _____
 ② _____
 ③ _____
 ④ _____
 ⑤ _____

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? Answer: Chromosome Structure

Fill in the blanks with the correct term, choosing from the following terms: *gene, locus, alleles, chromosome pair, chromosome.*


1 chromosome

2 chromosome pair

3 locus

4 gene


5 alleles

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? Question: Key Terms

Match the left key term with its definition on the right.


Homozygous	Observable expression of the genotype
Genotype	Having two copies of the same allele at a locus
Phenotype	Allelic make-up of a trait
Heterozygous	In heterozygotes, the allele that is not expressed in the phenotype
Recessive	Having two different alleles at a locus

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? Answer: Key Terms


Match the left key term with its definition on the right.

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Recessive	Having two different alleles at a locus

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Learning Summary

- The **modern evolutionary synthesis** integrated the theory of natural selection and modern genetics.
- Evolutionary biology** is interdisciplinary and studies the origin and changes in species and allele frequencies over time.
- Understanding **genetic inheritance and structure** is imperative in understanding evolution.
- Lamarck's** theory of use and disuse, or inheritance of acquired characteristics, is not a valid evolutionary theory.
- Darwin's **theory of natural selection** requires a trait has variation, heritability, and differential reproductive success for evolution to occur.



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Congratulations

**You have successfully
completed the tutorial**

**Introduction to
Evolutionary Thought**

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What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)

→ Step 2: Practice – Interactive Problem Drill

Step 3: Recap – Super Review Cheat Sheet

Go for it!



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