



# WELCOME TO TARTU

Evolution and the Natural World  
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# INTRO

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Evolution and the Natural World

Lecture 2

16/09/2021

Vasili Pankratov

# Materials

- Moodle: lecture slides, videos, etc.
- Evolution book (N. Barton and co-authors)
- Take lecture notes

# Goals: the SciTech program

- Help you with your career choices
- Promote interdisciplinarity

# Goals: the EATNW course

- Very general overview of biology from an evolutionary perspective (how do we currently understand life?)
- Overview of human evolution
- Some insight into and promotion of current research in human evolutionary genetics

# Evaluation

Final score =

0.1 x test score +

0.3 x presentation score +

0.6 x exam score

Final score:

- <50% - fail
- 50-60% - E
- 60-70% - D
- 70-80% - C
- 80-90% - B
- 90-100% - A

# BACK TO SCHOOL: GENETICS

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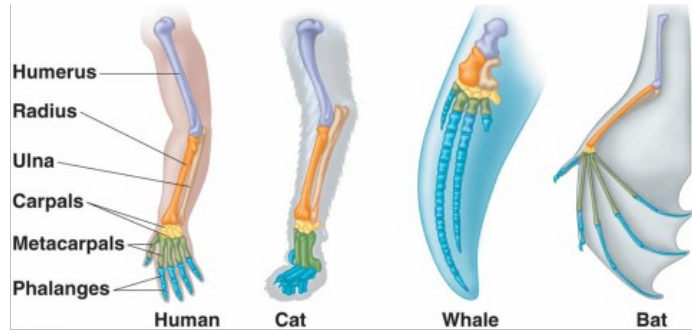
Evolution and the Natural World

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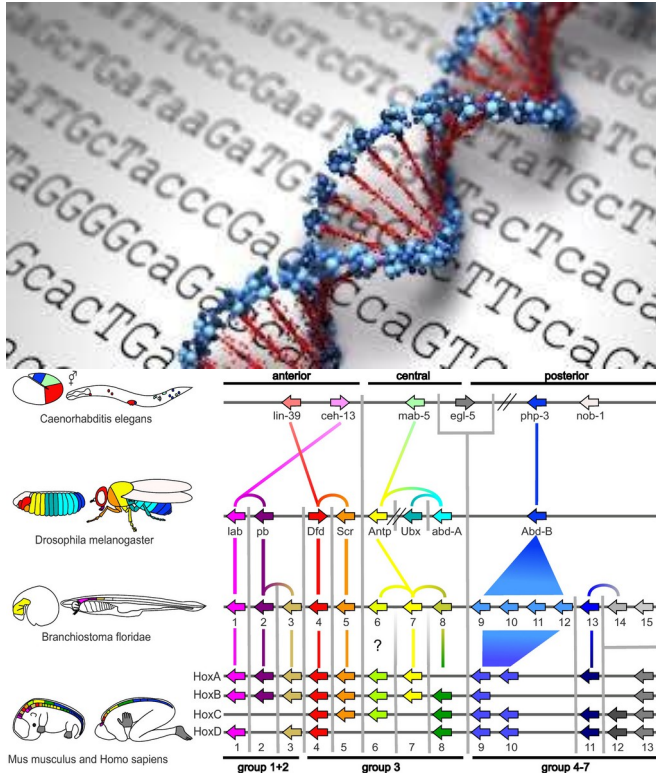
# Evolutionary Biology in the 19<sup>th</sup> Century



- Paleontology
- Comparative morphology
- Comparative anatomy
- Comparative embryology
- Biogeography



# Evolutionary Biology in the 21<sup>th</sup> Century



- Molecular Biology
- Genomics
- Evolutionary developmental biology
- Ecology
- Experimental evolution
- Modeling and simulations

# Modern Theory of Evolution

- It is impossible to understand modern evolutionary theory without knowing other fields of biology
- Darwin's theory of evolution  $\neq$  modern theory
- Modern theory of evolution  $\neq$  ultimate theory
- New data adds to and modifies our understanding of evolution – still a lot to be learned

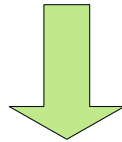
# What is Evolution?

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- Descent with modification
- Sometimes new traits emerge and can be passed on to offsprings
- Some traits are “better” than others (increase fitness) – such traits spread over generations

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## Genetics

# GENETICS

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How does inheritance work?

# I. Mendel's experiments

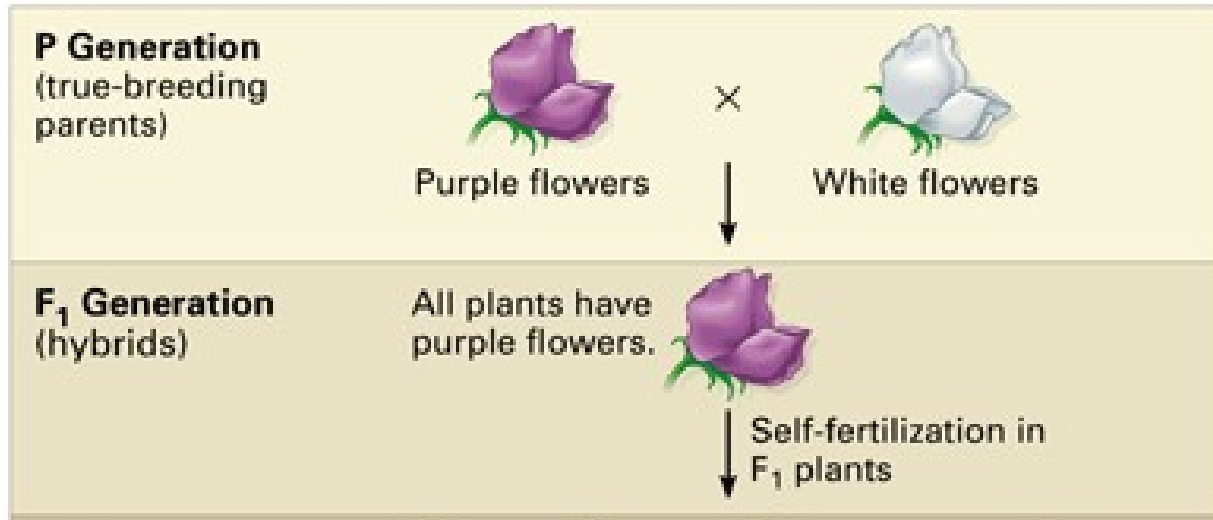
	Flower color	Flower position	Seed color	Seed shape	Pod shape	Pod color	Stem length
P	Purple  ×  White	Axial  ×  Terminal	Yellow  ×  Green	Round  ×  Wrinkled	Inflated  ×  Constricted	Green  ×  Yellow	Tall  ×  Dwarf
F <sub>1</sub>	 Purple	 Axial	 Yellow	 Round	 Inflated	 Green	 Tall

# I. Mendel's experiments

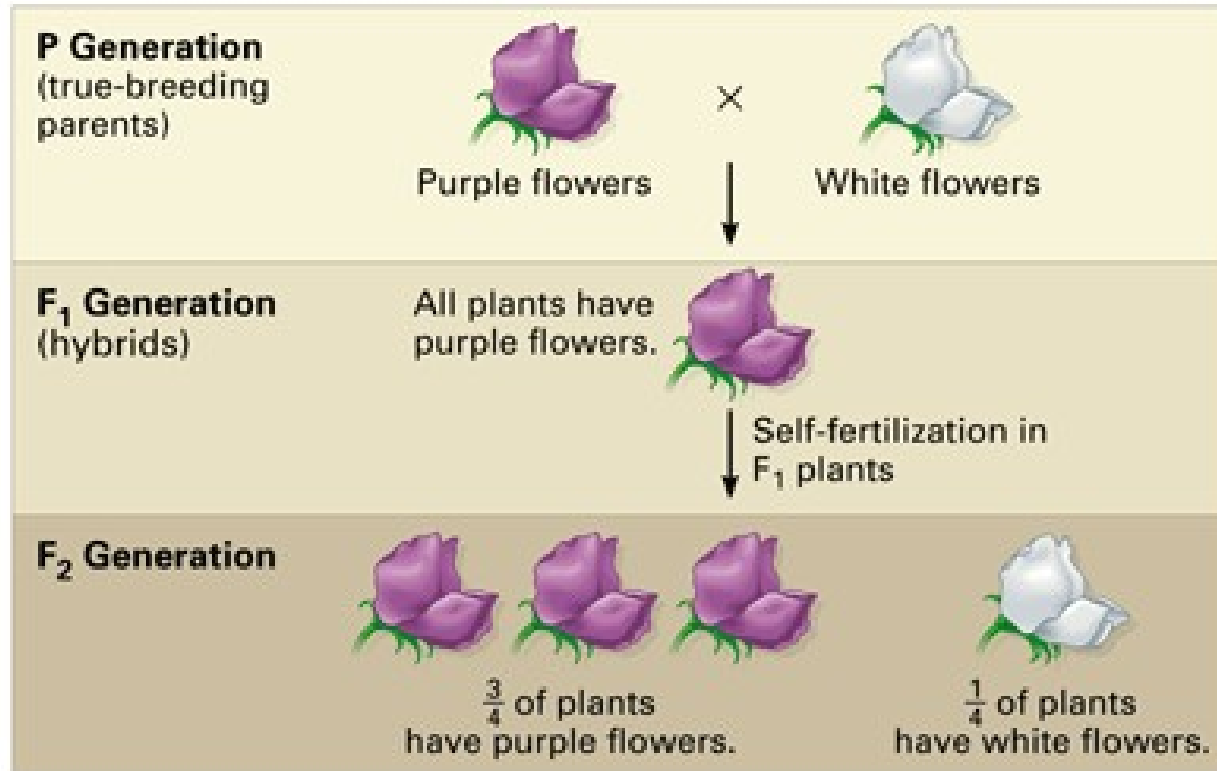




# I. Mendel's experiments



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# I. Mendel's experiments: conclusions

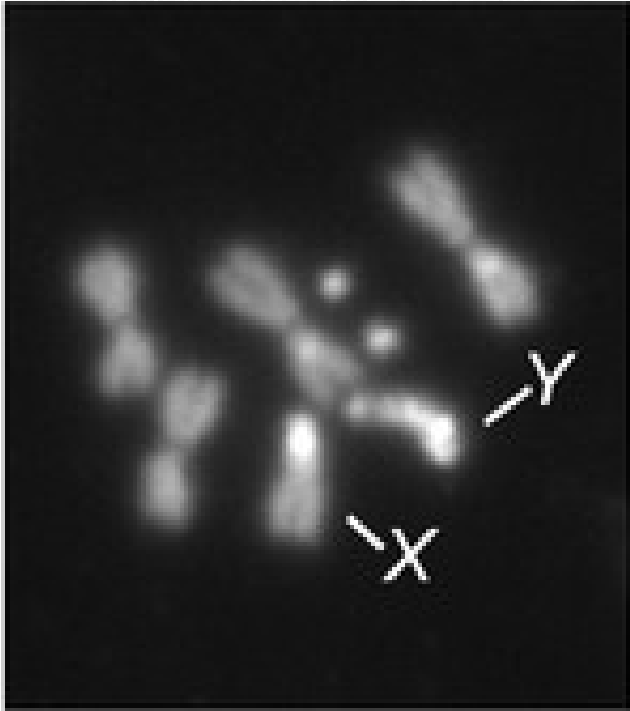
- There are some discrete heritable entities that determine the phenotype (traits) – **genes**
- Pea plants (and many other species) are **diploid** – each individual has two “copies” of each gene
- Genes come in different versions – **alleles**
- Each individual has a combination of two alleles for a given gene – **genotype**.
- An organism can be a **homozygote** or a **heterozygote** for a given gene

# I. Mendel's experiments: conclusions

- In many cases one allele is **dominant** over the other (which is **recessive**) – the phenotype of a heterozygote (Aa) is the same as the phenotype of a homozygote for the dominant allele (AA)

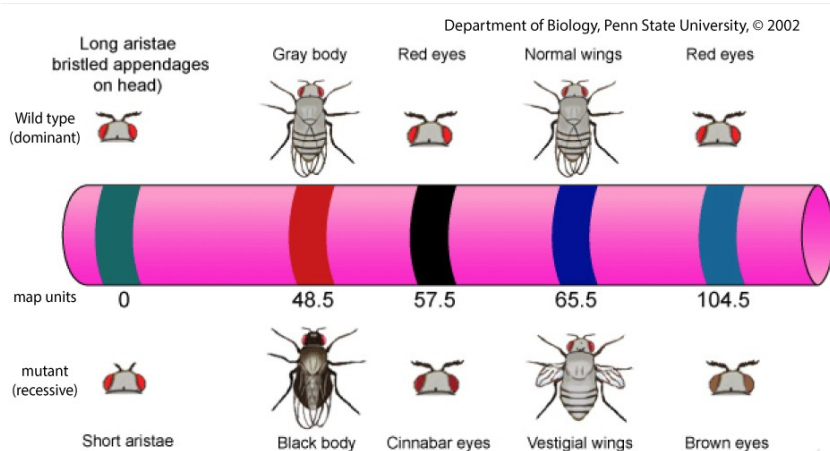
## II. Chromosomal theory of inheritance

### *D. melanogaster*



- Chromosomes come in pairs – **homologous chromosomes**
- Gametes have only 1 chromosome from each pair – **haploid**
- Some genes in Drosophila behave as if females had 2 copies, but males had 1 – **X-linked** traits

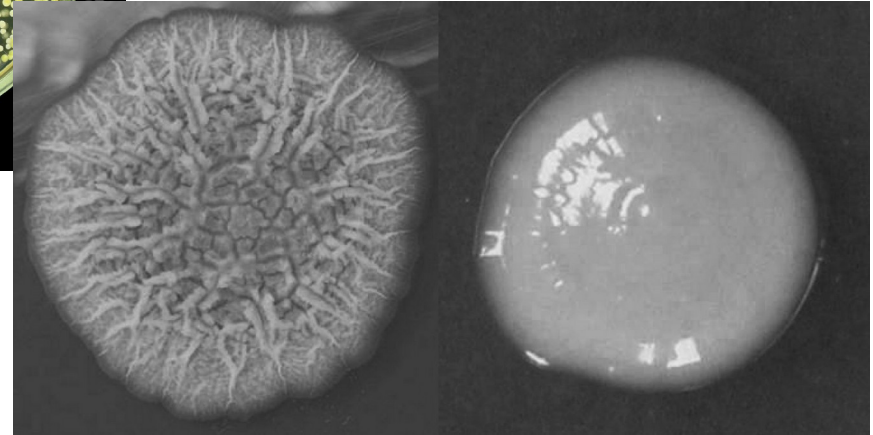
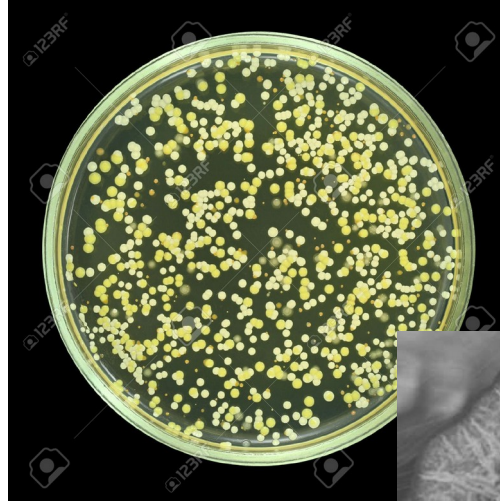
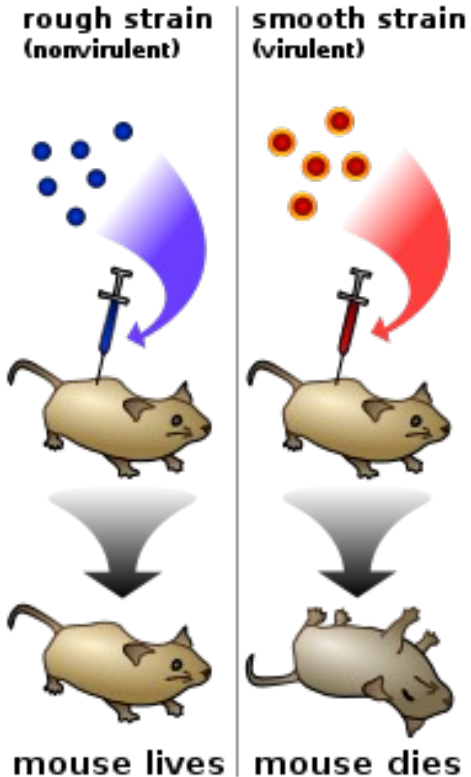
# II. Chromosomal theory of inheritance



- Some traits are **linked**
- Genes are grouped into **linkage groups** – correspond to chromosomes
- Genes are arranged linearly
- **Genes are chromosomal segments**

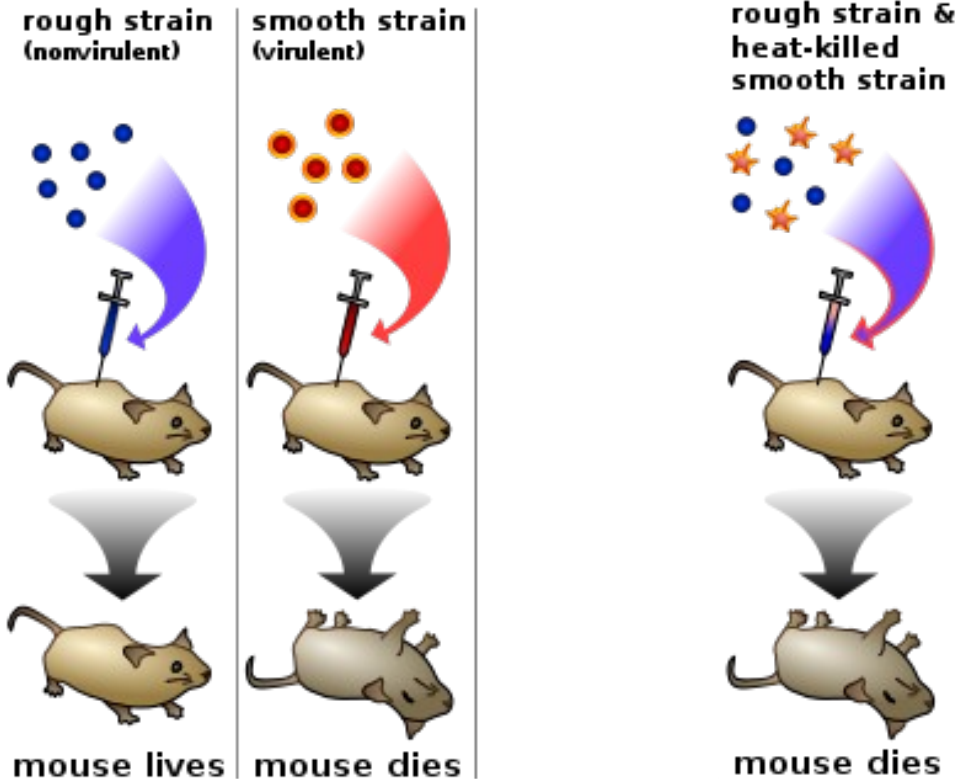
<https://sciencemusicvideos.com/ap-biology/genetics-mendelian-blood-type-sex-linkage/linked-genes/>

# III. Genes are made of DNA



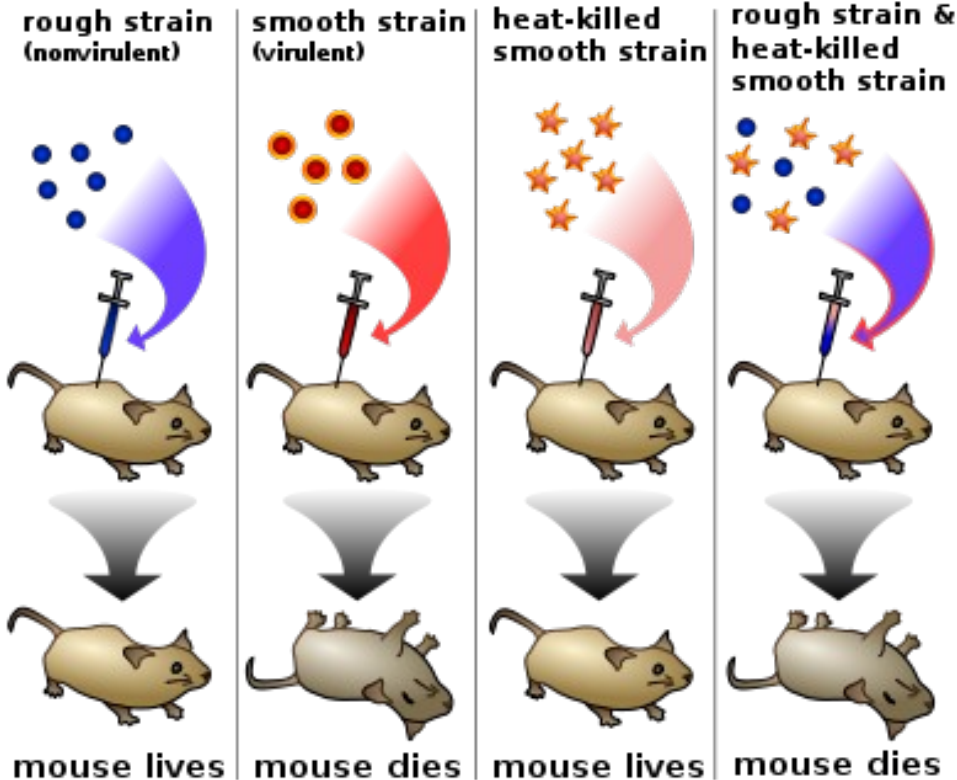
Wikipedia, Madeleine Price Ball

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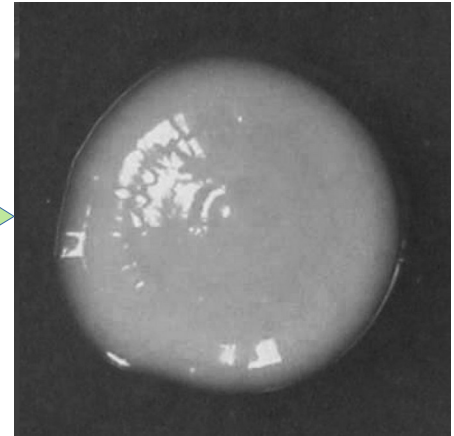
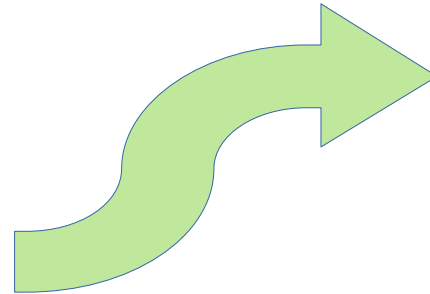
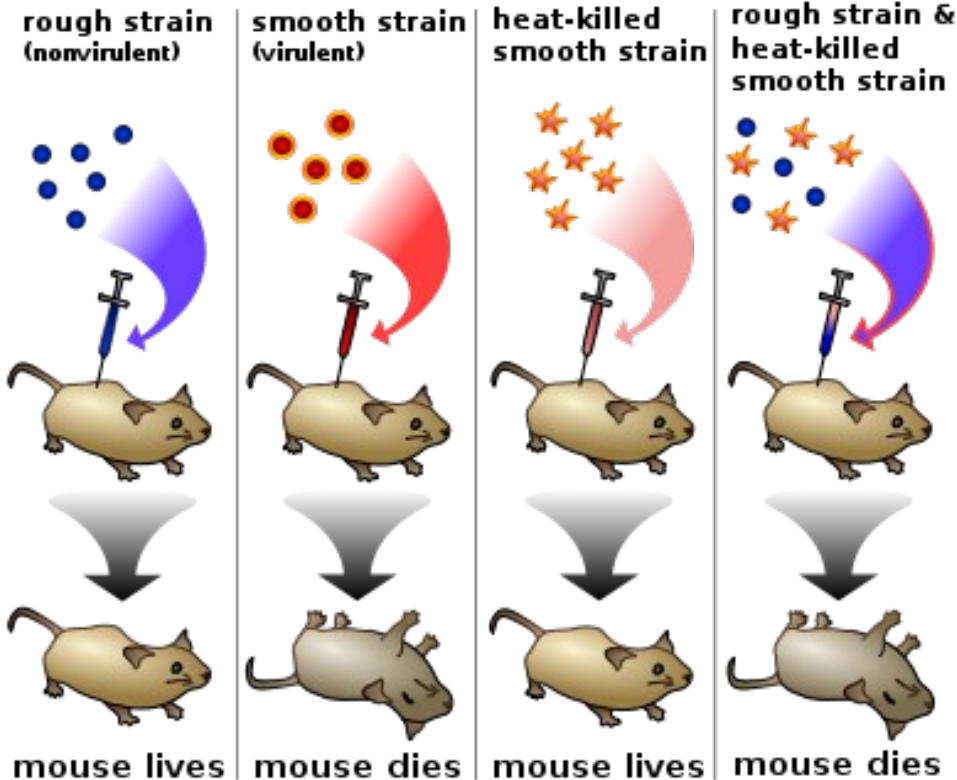




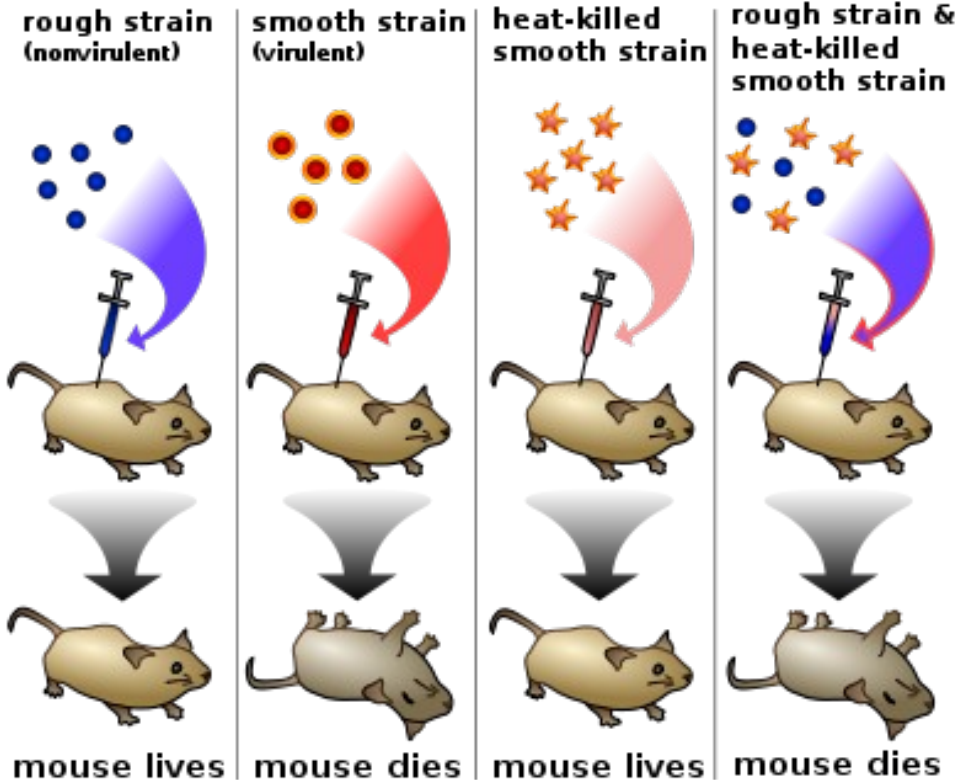
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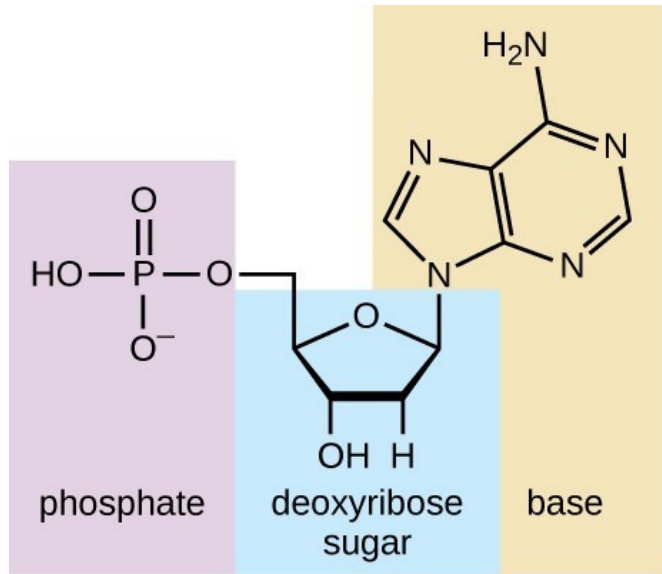


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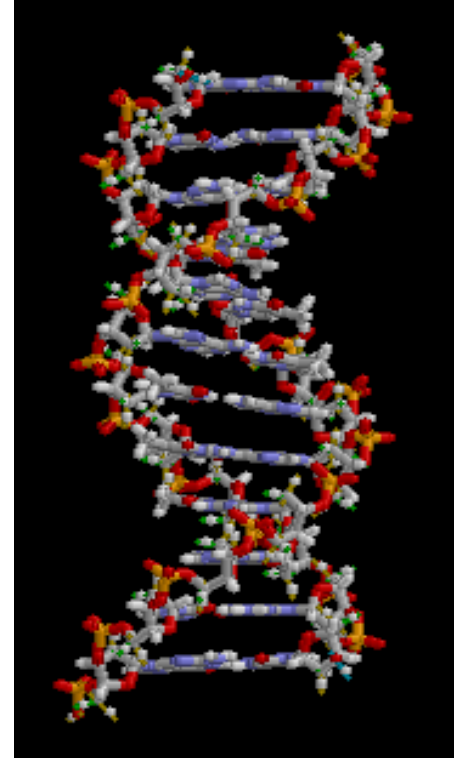
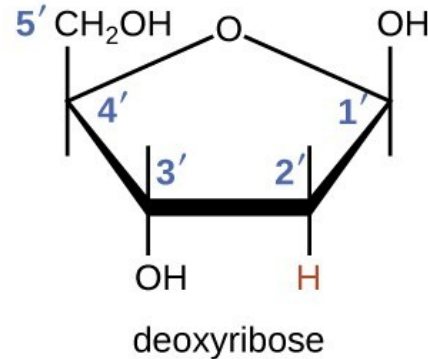


- Non-virulent (R) *Streptococcus* strain can be **transformed** into a virulent strain (S) by something present in heat-killed S cells
- DNA was found to be the “transforming principle”

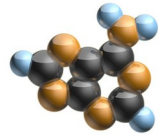
# IV. DNA structure



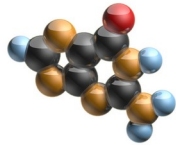
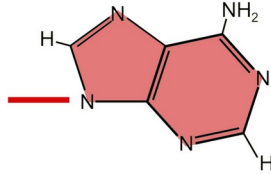
nucleotide



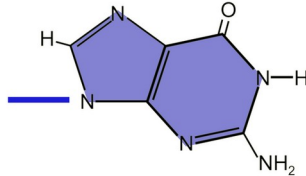
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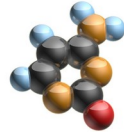
Adenine



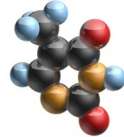
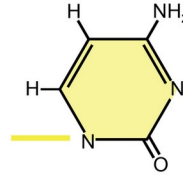
Guanine



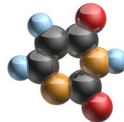
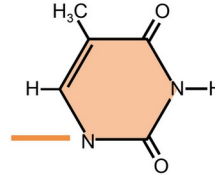
## Purines



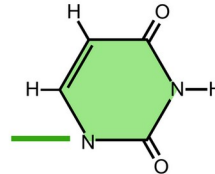
Cytosine



Thymine  
(DNA Only)



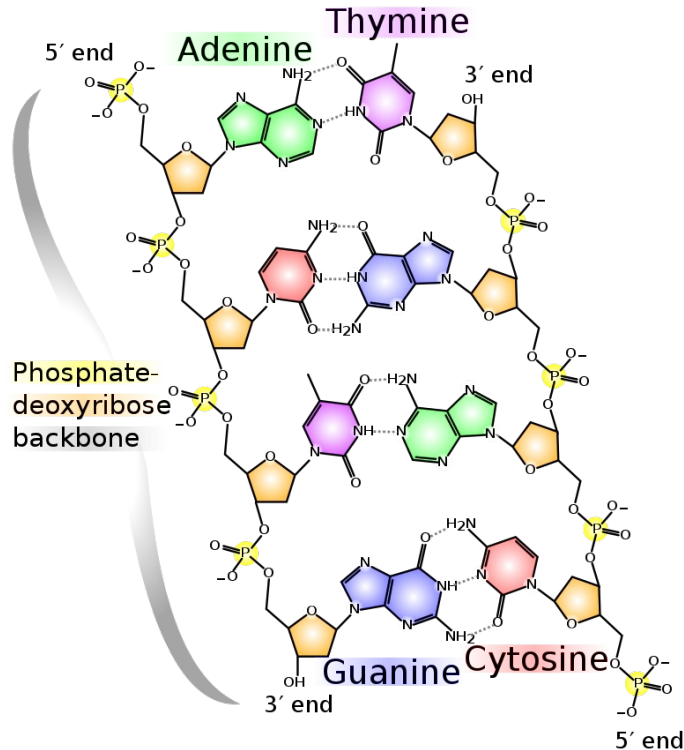
Uracil  
(RNA Only)



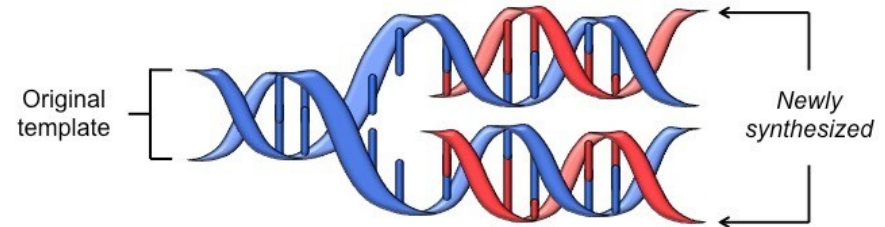
## Pyrimidines

- Bases can be grouped into 2 classes based on their chemical structure

# IV. DNA structure



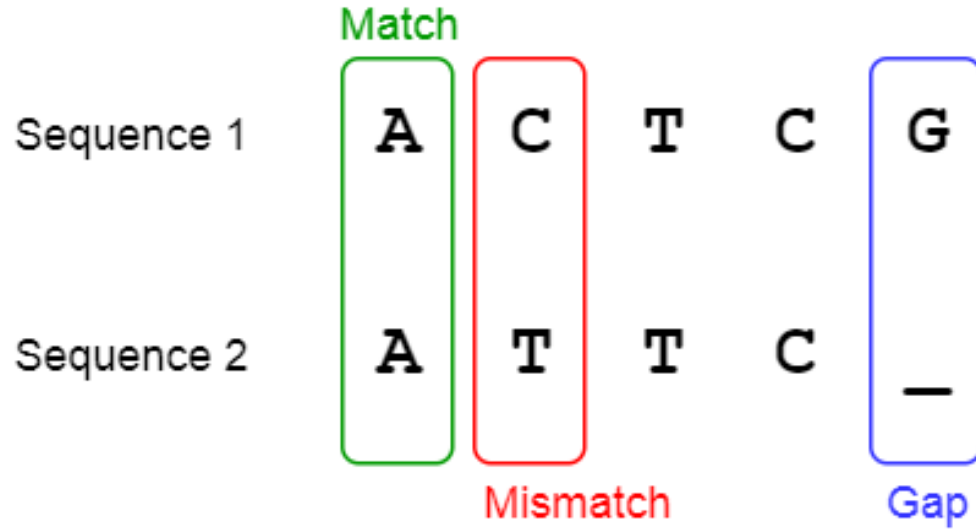
- Four types of nucleotides with no restrictions on the sequence – DNA contains information
- Base-pairing is the key to copying and “reading” this information



Wikipedia, Madeleine Price Ball

<https://ib.bioninja.com.au/standard-level/topic-2-molecular-biology/27-dna-replication-transcri/semi-conservative.html>

## IV. Differences in DNA structure



Alleles of the same gene differ slightly in terms of their nucleotide sequence

# Genetics: key points

- Genes are units of inheritance
- Physically genes are chromosomal regions
- Chromosomes are made of DNA so genes are segments of DNA
- Genes are defined by the nucleotide sequence
- Alleles are gene versions with slightly different nucleotide sequence
- So small differences in nucleotide sequence may lead to differences in phenotype (trait)