Model Organisms

Course 281

Introduction to Molecular Biology

Lessons for life

The object of education is to teach us to love what is beautiful.

Plato, The Republic

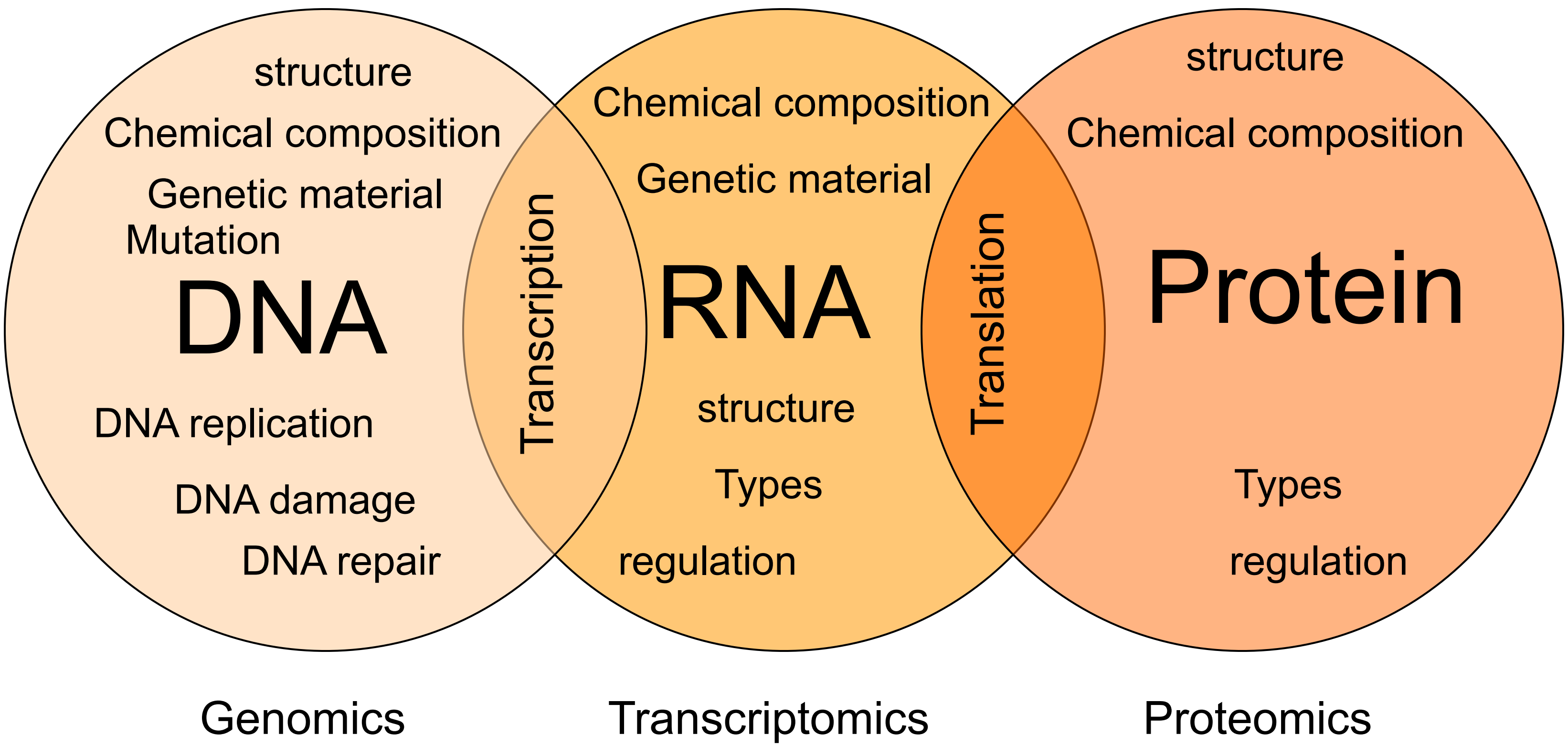
like

AIMS

- Understand the importance of models in science.
- Introduce models organisms.
- Present the most important model organisms.
- Present the general characteristics of the model organisms.

The molecules

This class is about the molecules of life !



The molecules

How can we study these molecules?

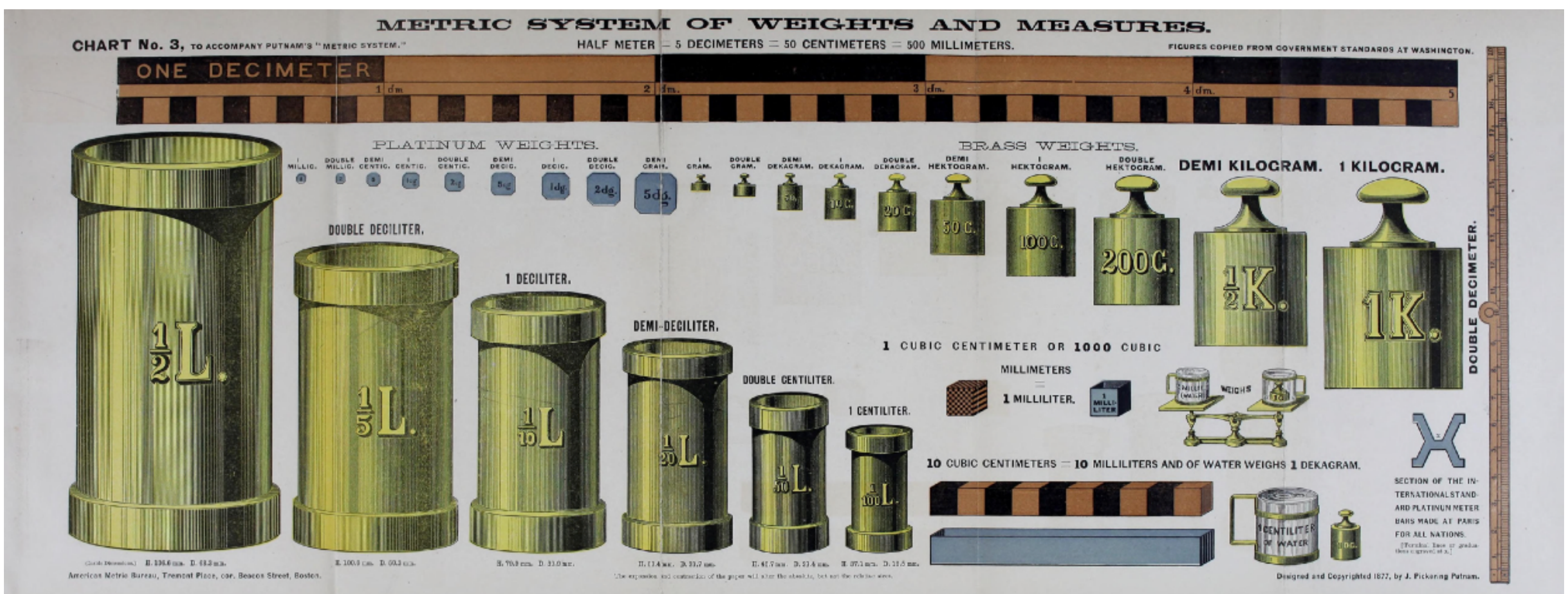
How can we learn about their biology?

We need models!

All branches of science need model systems

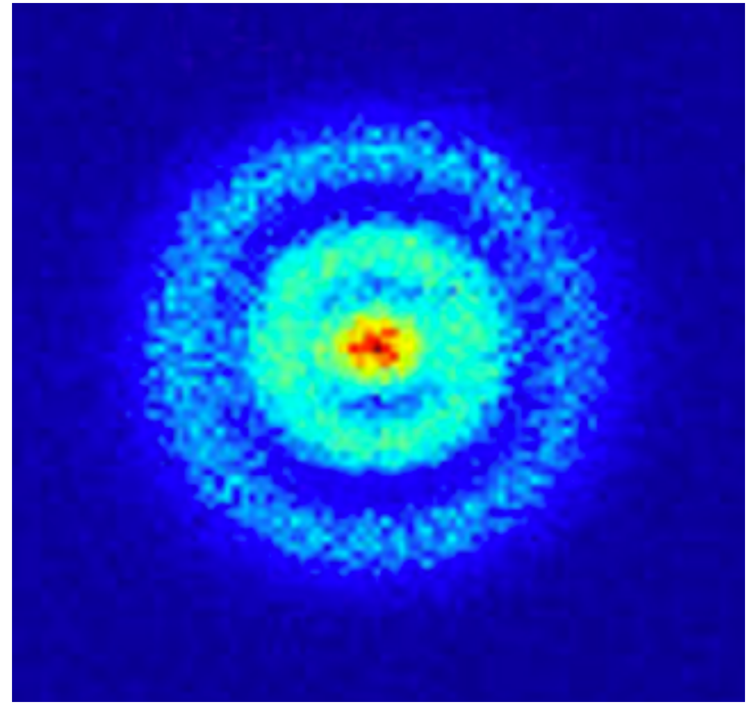
Science and models

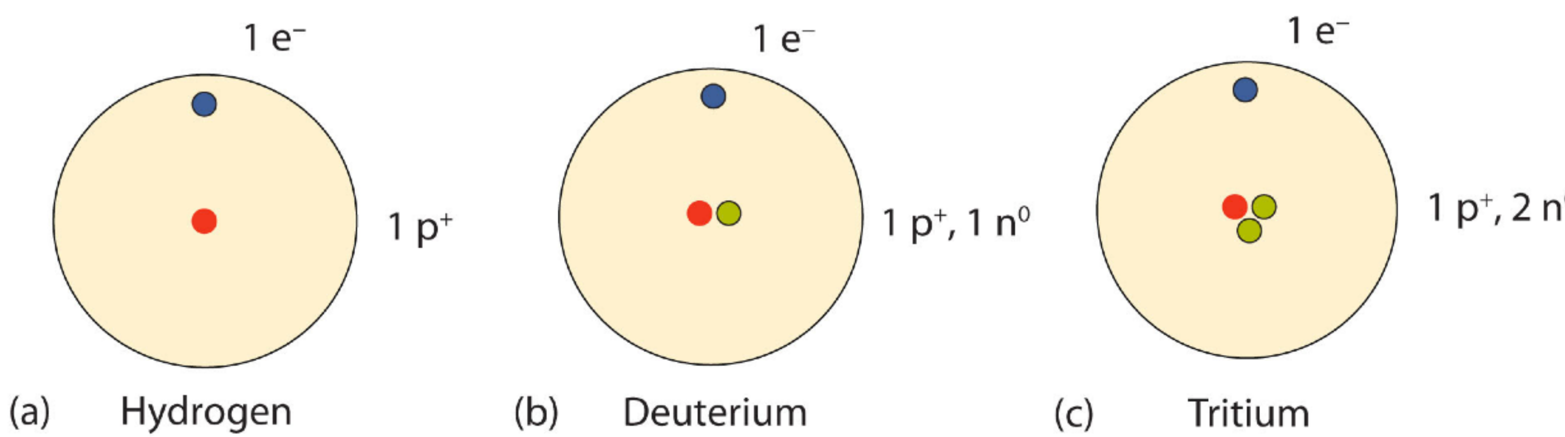
- To study physical sciences, we need a model of weights, volumes etc.
- We need a simple system that can be easily studied to gain the knowledge to understand more complicated systems.



Science and models

- The hydrogen atom is a model to study physics and chemistry.
- The hydrogen atom is simple (one proton and one electron).





Model organisms

How do we learn about all these molecules and mechanisms involved?

Bacteriophage (virus)

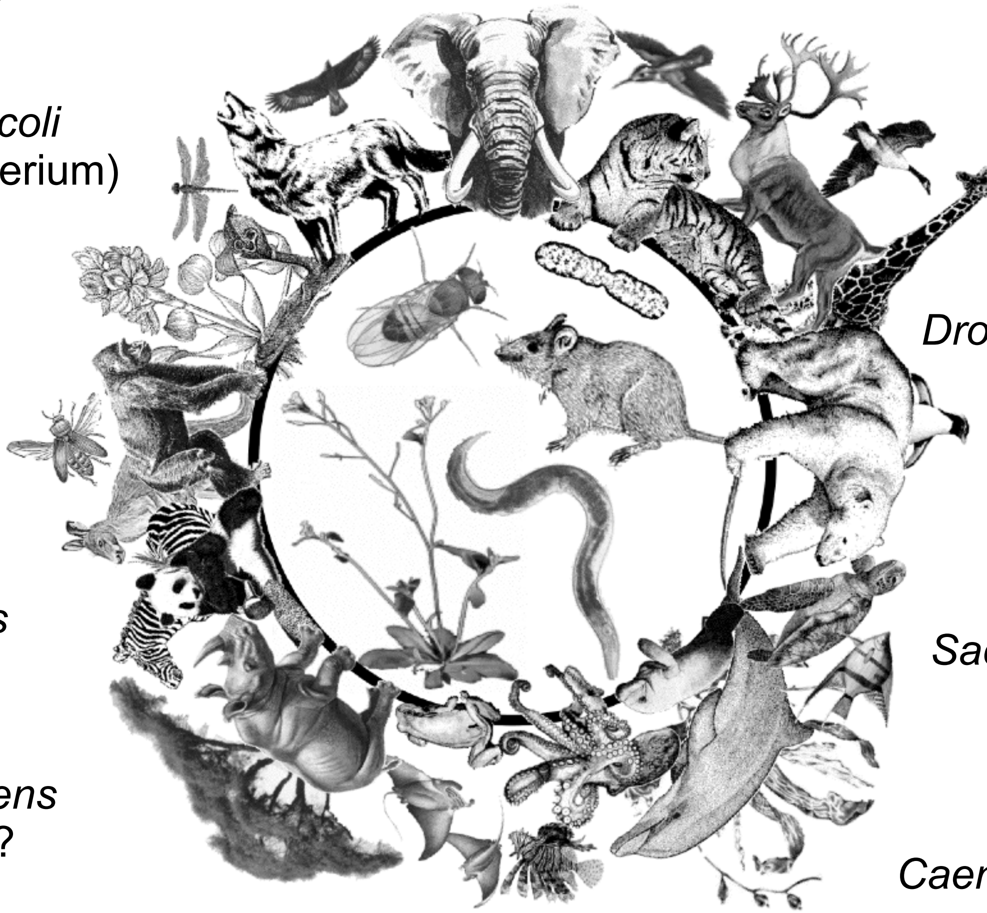
Escherichia coli (intestines' bacterium)

Zea mays (corn)

Danio rerio (zebrafish)

Mus musculus (mouse)

Homo sapiens (Human)?



Arabidopsis thaliana (plant)

Neurospora crassa (bread mold)

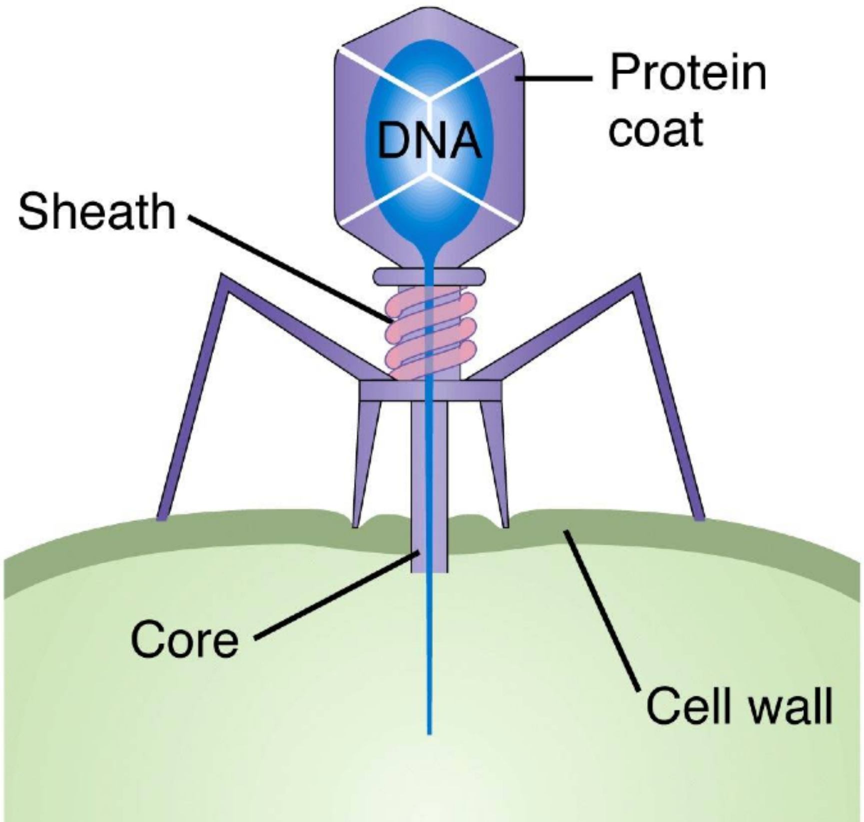
Drosophila melanogaster (fruit fly)

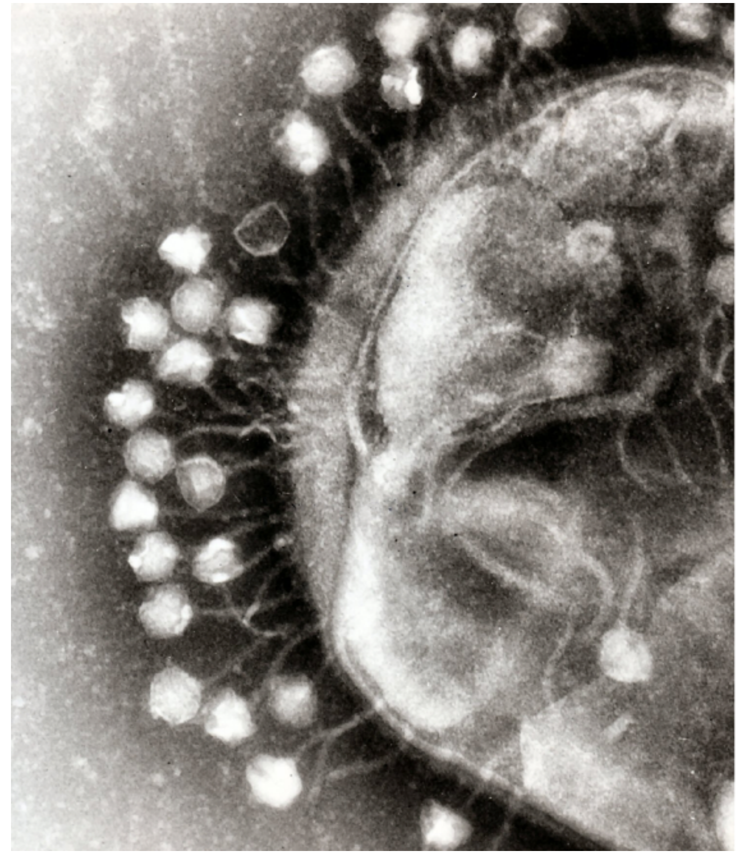
Pisum sativum (garden pea)

Saccharomyces cerevisiae (budding yeast)

Caenorhabditis elegans (worm)

Bacteriophage (virus)

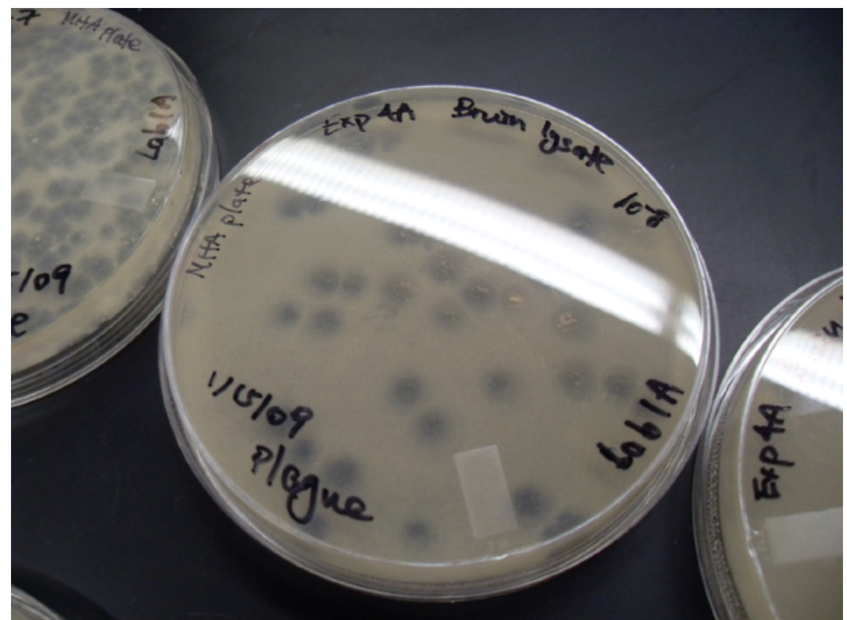




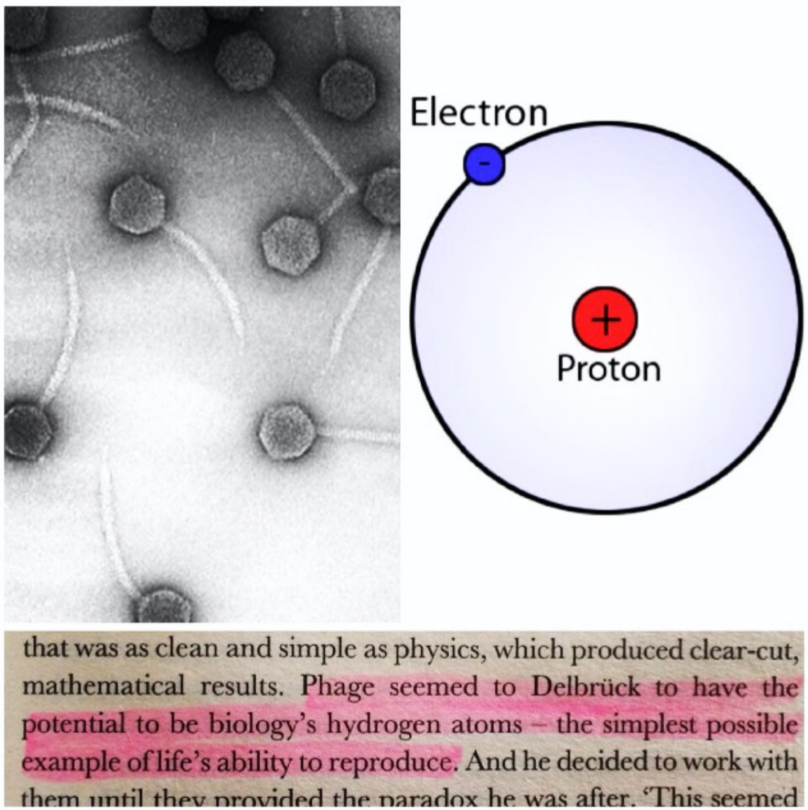
- Virus (living?)
- 24-200 nm in length
- single entities.
- Simple structure
- Haploid

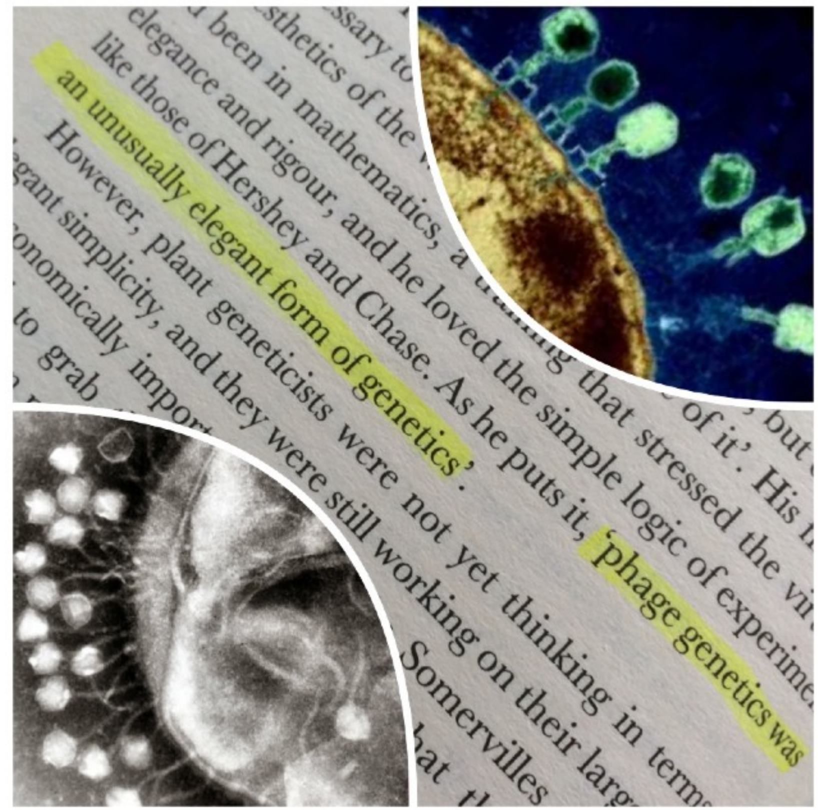
Bacteriophage (virus)

- Grows on/in bacteria
- Can be grown into millions of copies
- Fast growth
- Easy to culture, store, and manipulate genetically



Bacteriophage (virus)

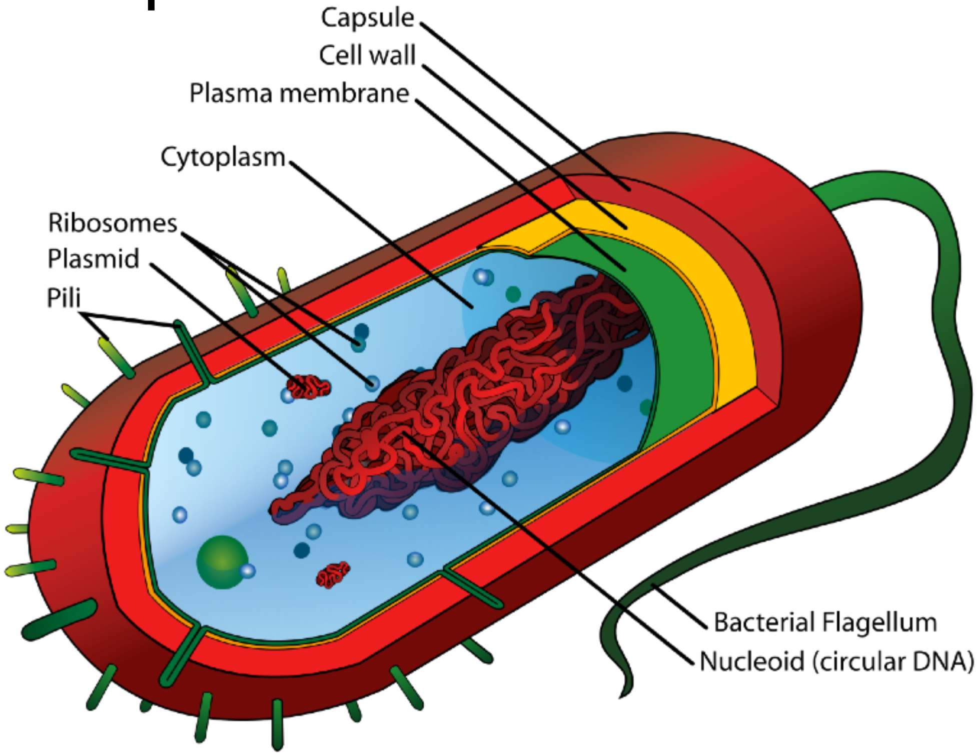


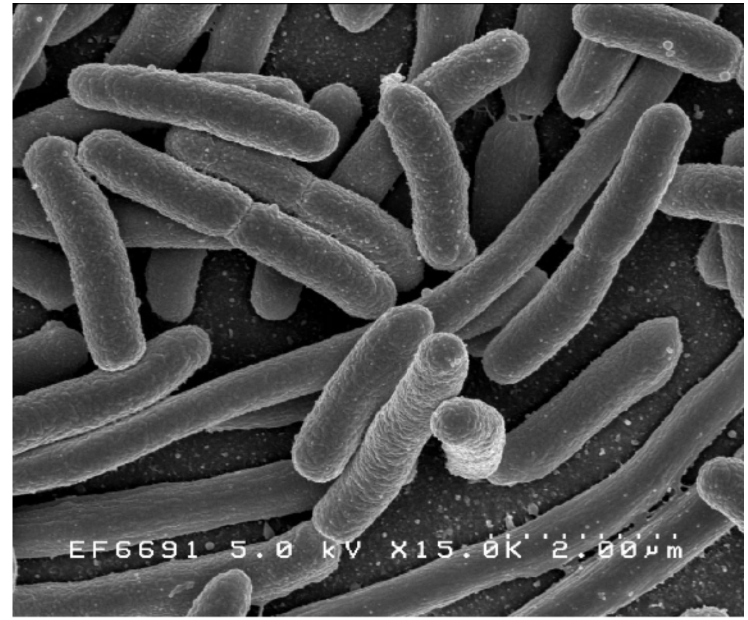


The hydrogen atom for biologists

Escherichia coli (intestines' bacterium)

- Prokaryote.
- Single celled organism.
- haploid

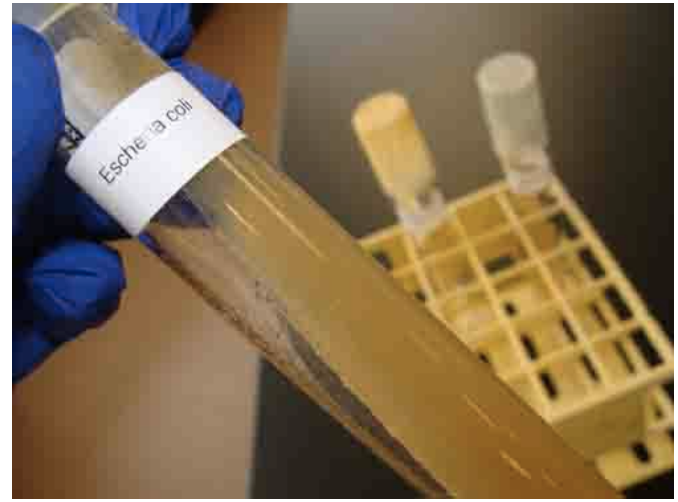




- Small in size
- ~ 2um in length
- ~ 0.5 um in width

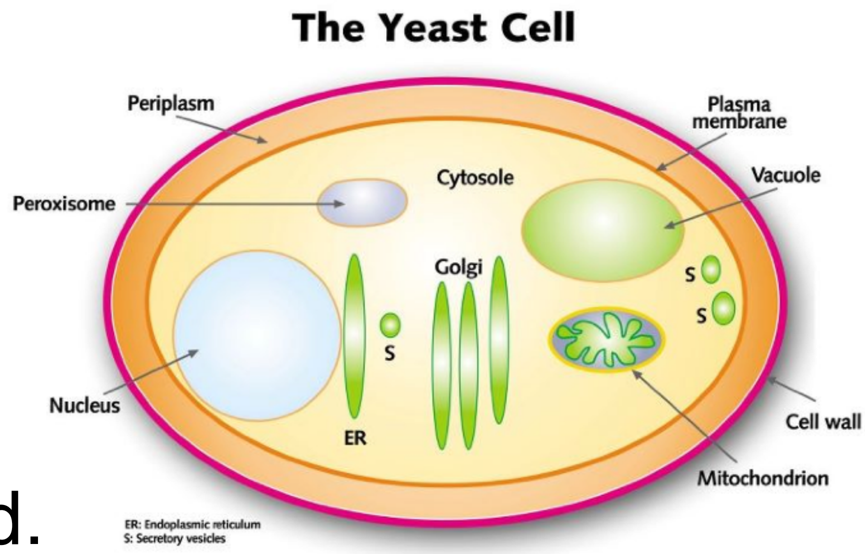
Escherichia coli (intestines' bacterium)

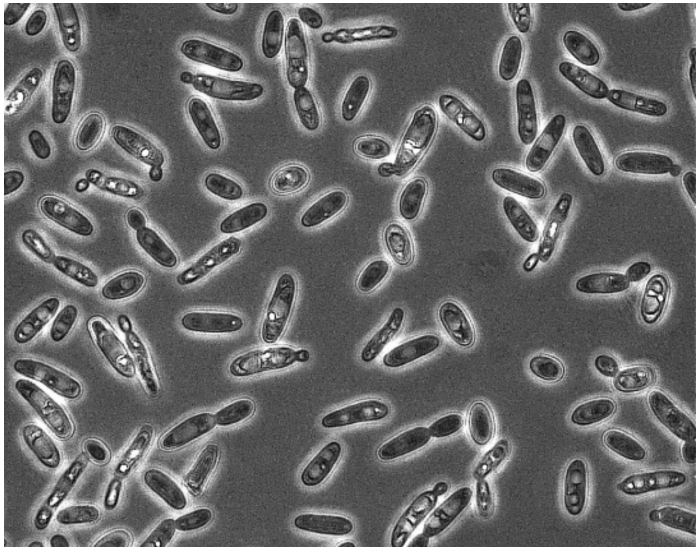
- Easy to grow in lab
- Can be grown into millions of copies
- Fast growth
- Easy to culture, store, and manipulate genetically



Saccharomyces cerevisiae (budding yeast)

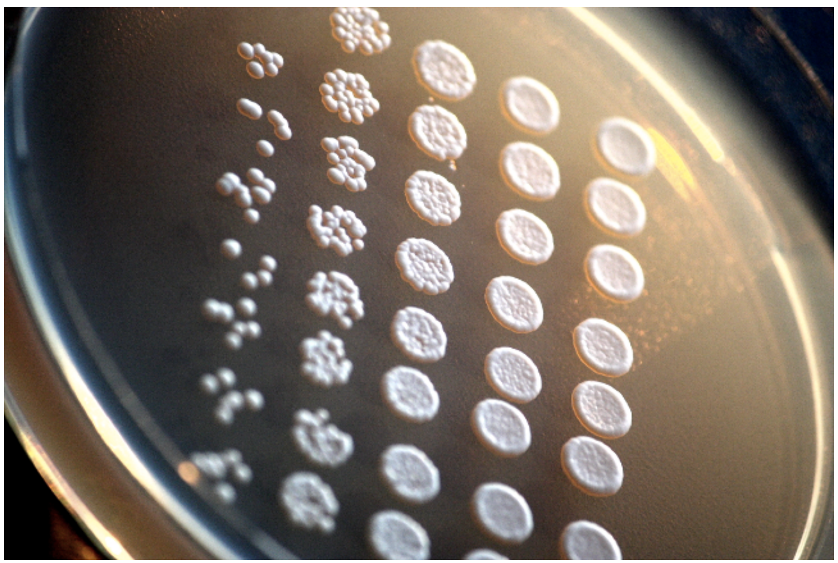
- Eukaryote.
- Fungi.
- Single celled organism.
- Grows haploid or diploid.
- Sexual and asexual life cycles.
- Small in size (~ 5-10 um in diameter).





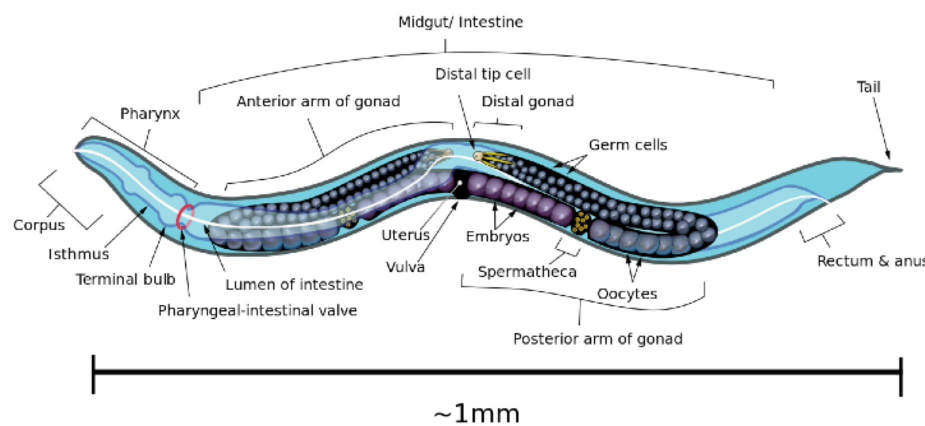
Saccharomyces cerevisiae (budding yeast)

- Easy to grow in lab
- Fast growth
- Easy to culture, store, and manipulate genetically



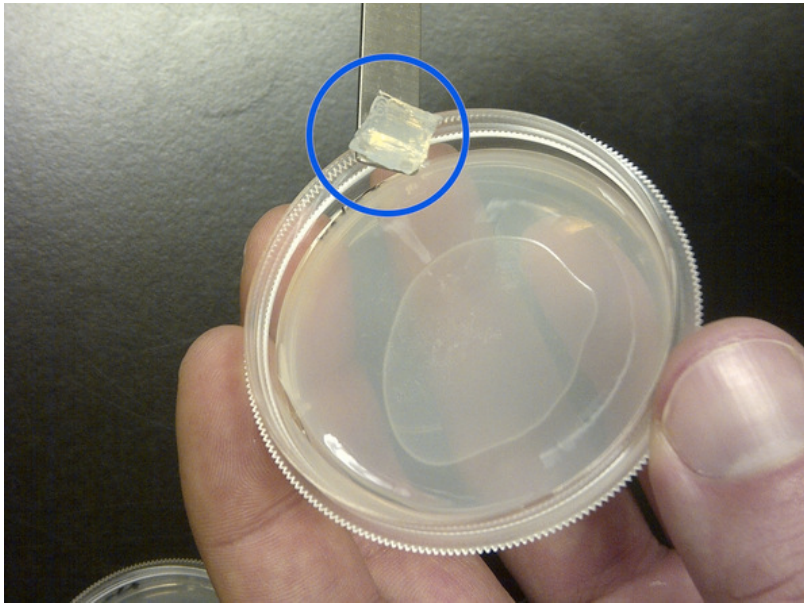
Caenorhabditis elegans (worm)

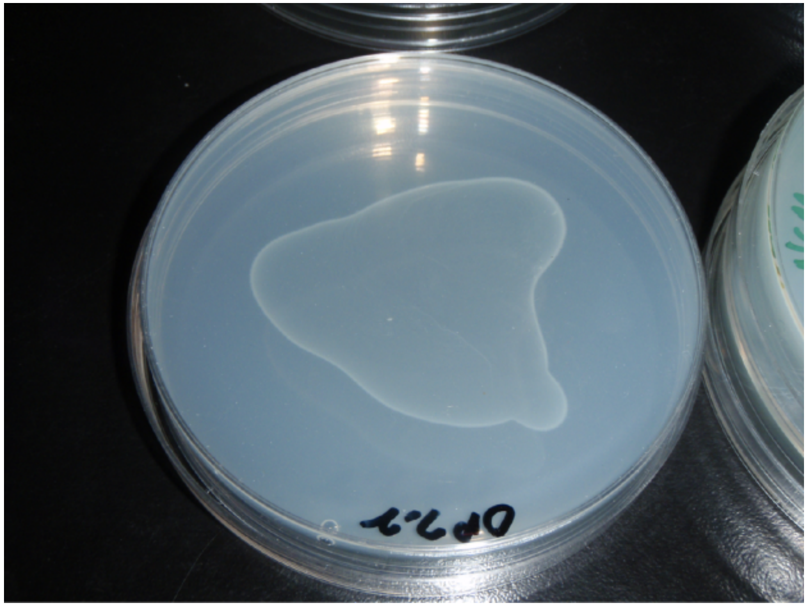
- Eukaryote.
- Animal - Nematode.
- Multicellular.
- Hermaphrodite.
- Sexual and asexual life cycles.
- Small in size (~ 1 mm in length).
- Diploid.



Caenorhabditis elegans (worm)

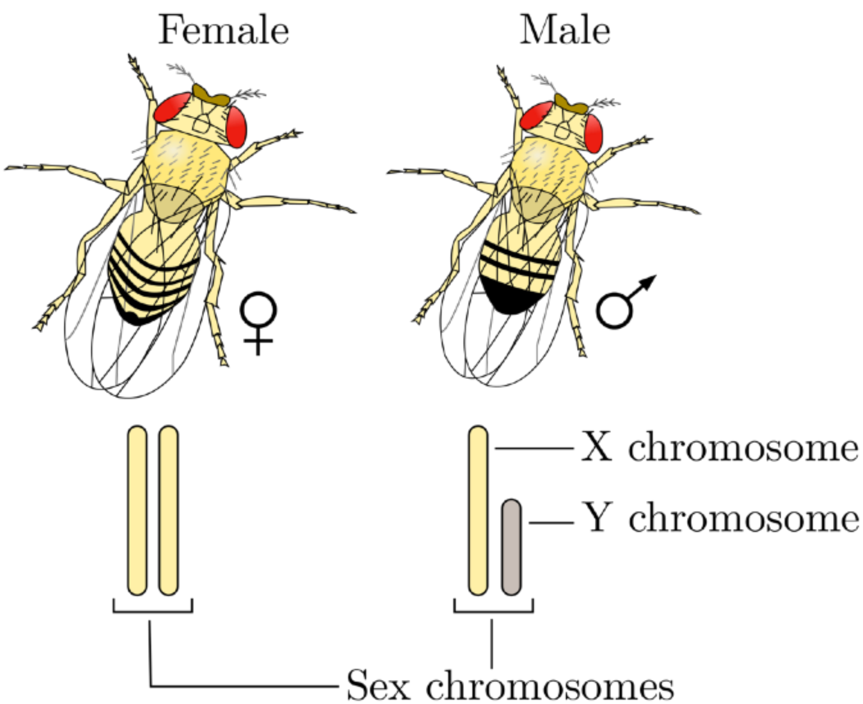
- Easy to grow in lab
- Fast growth
- Short life cycle
- Known number of cells





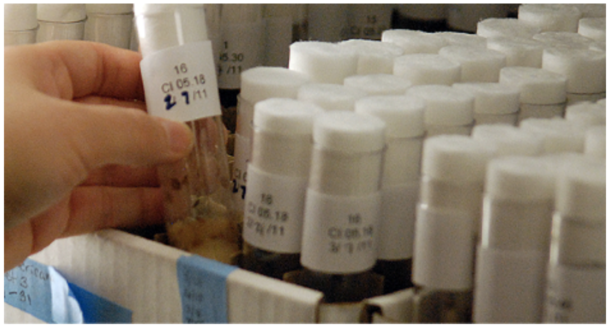
- Easy to culture, store, and manipulate genetically.
- Eggs can be stored.

Drosophila melanogaster (fruit fly)



- Eukaryote.
- Animal - Insect.
- Multicellular.
- Diploid
- Sexual life cycle.
- Sexual dimorphism
- ~ 2.5 mm in length

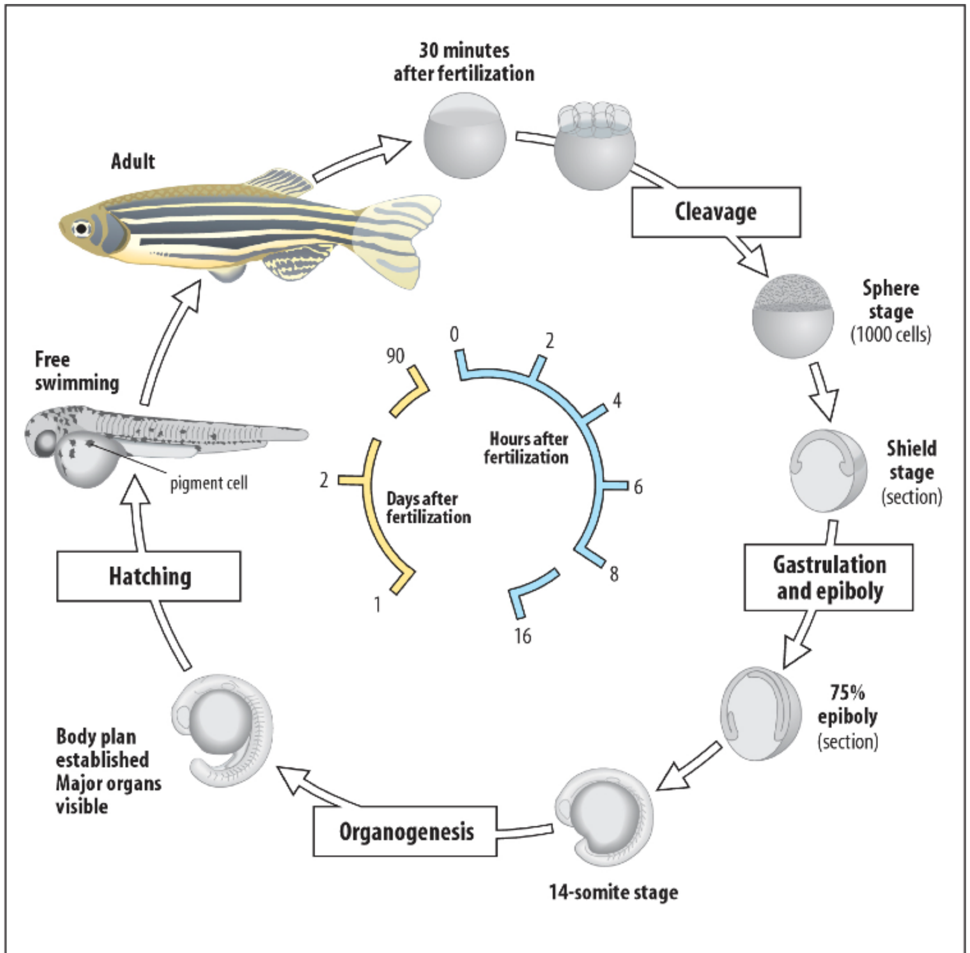
Drosophila melanogaster (fruit fly)

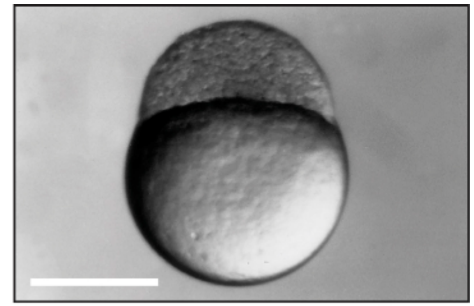


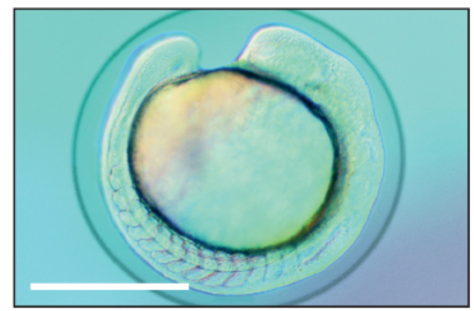
- Easy to grow in lab
- Occupies relatively a small space
- Short life cycle
- Easy and manipulate genetically.
- A living stock has to be maintained.

Danio rerio (zebrafish)

- Eukaryote.
- Diploid.
- Animal - Vertebrate.
- 4-6 cm in length.

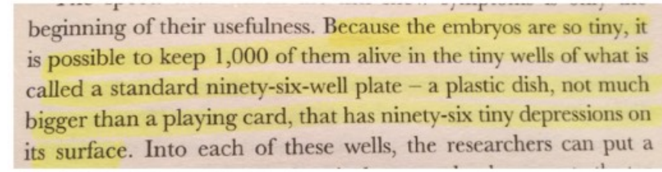


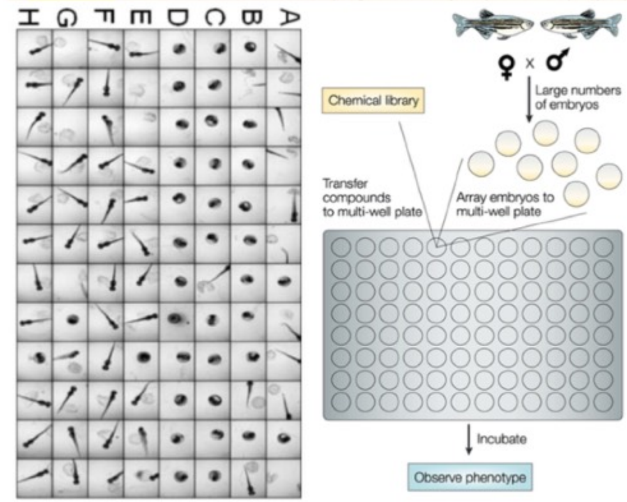


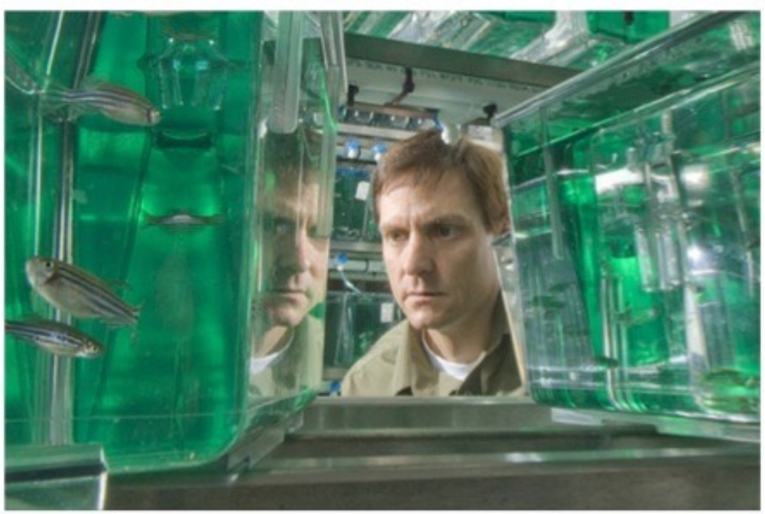


Danio rerio (zebrafish)

- Easy to grow in lab
- Occupies relatively a small space
- Short life cycle
- Good development model.

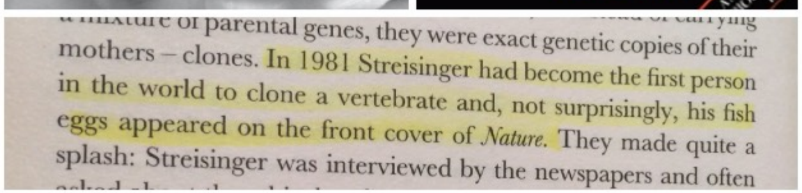

beginning of their usefulness. Because the embryos are so tiny, it is possible to keep 1,000 of them alive in the tiny wells of what is called a standard ninety-six-well plate – a plastic dish, not much bigger than a playing card, that has ninety-six tiny depressions on its surface. Into each of these wells, the researchers can put a





Danio rerio (zebrafish)

- First cloned vertebrate!
- Fun scientific community.


mixture of parental genes, they were exact genetic copies of their mothers – clones. In 1981 Streisinger had become the first person in the world to clone a vertebrate and, not surprisingly, his fish eggs appeared on the front cover of *Nature*. They made quite a splash: Streisinger was interviewed by the newspapers and often

Mus musculus (mouse)

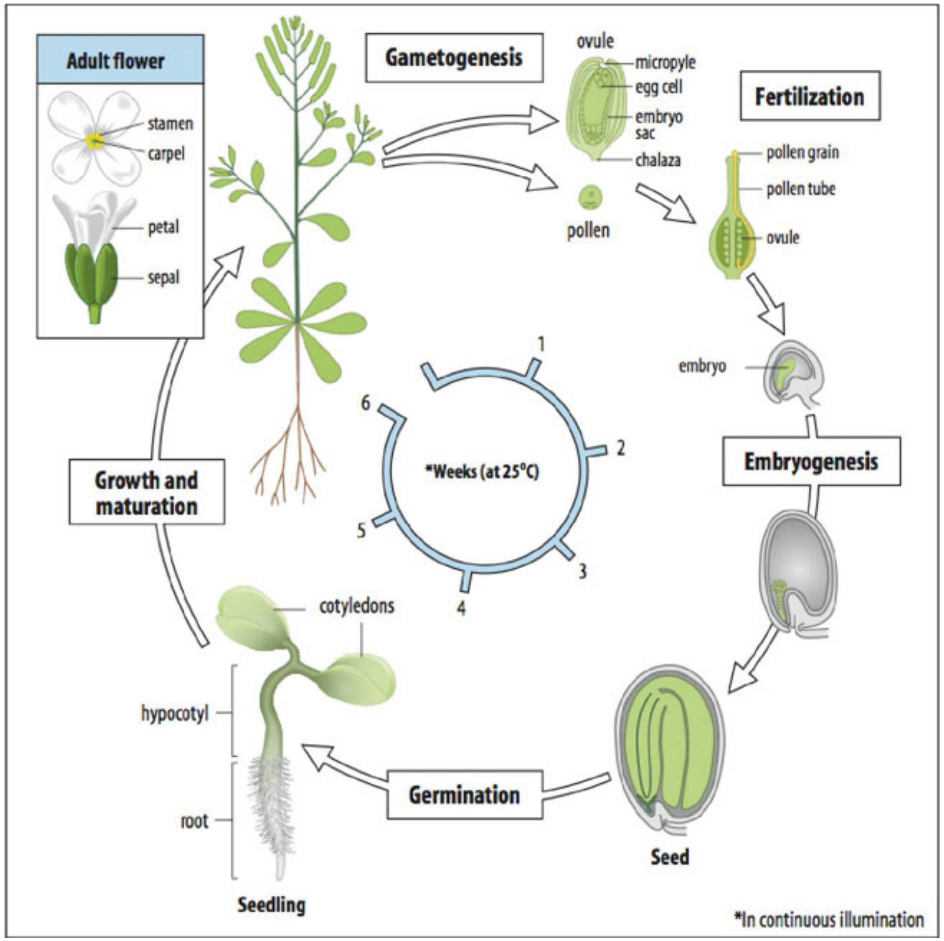
- Eukaryote.
- Animal - mammal.
- Diploid
- Model for human.
- Small mammal.
- 7.5 - 10 cm in length.
- Long history as a model in biology and medicine.

Mus musculus (mouse)

- Small mammal.
- Can be grown in lab.
- Genome can be manipulated.
- Knockout mice.
- A variety of phenotypes can be studied.

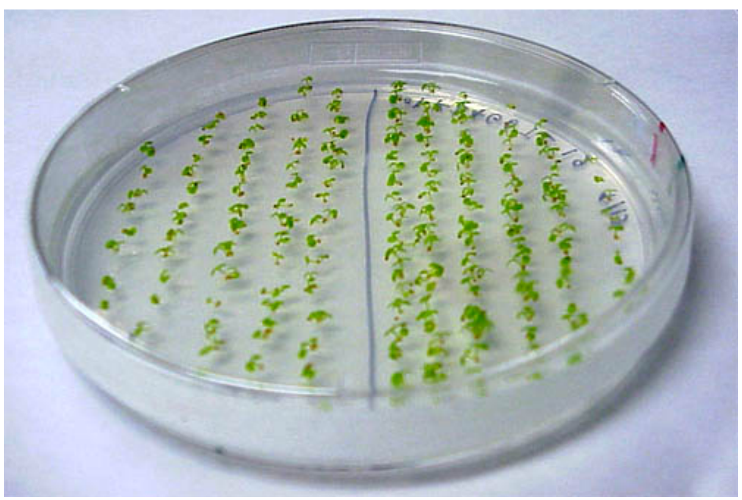
Arabidopsis thaliana (plant)

- Eukaryote.
- Plant - Dicot.
- Diploid.
- 20-25 cm in height



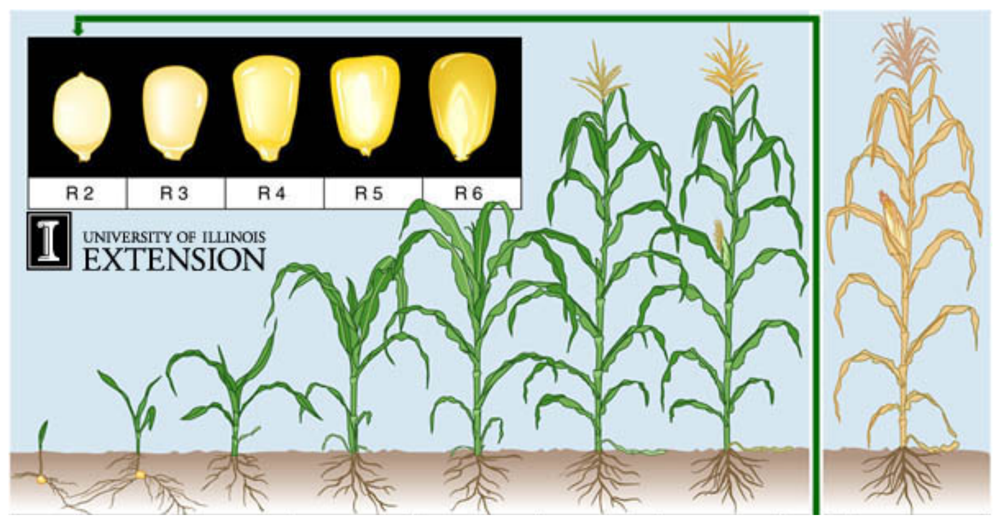
Arabidopsis thaliana (plant)

- Easy to grow in lab
- Occupies a small space
- Short life cycle
- Easy to cross
- Seeds can be stored.



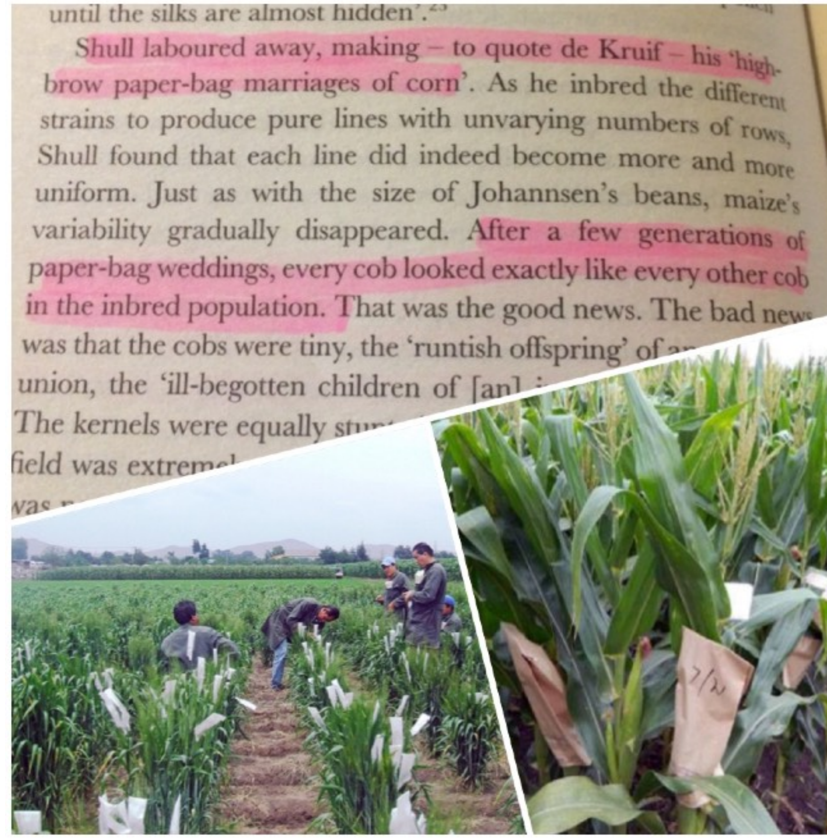
Zea mays (corn)

- Eukaryote.
- Plant - monocot.
- Diploid.
- Agricultural importance.
- ~ 2.5 m in height.



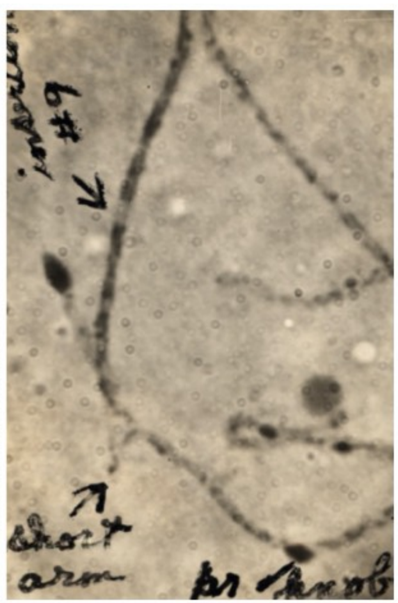
Zea mays (corn)

- Large plant.
- Can't be held in lab.
- Crosses must be conducted in the field.
- Long breeding history



until the silks are almost hidden'.

Shull laboured away, making – to quote de Kruif – his 'high-brow paper-bag marriages of corn'. As he inbred the different strains to produce pure lines with unvarying numbers of rows, Shull found that each line did indeed become more and more uniform. Just as with the size of Johannsen's beans, maize's variability gradually disappeared. After a few generations of paper-bag weddings, every cob looked exactly like every other cob in the inbred population. That was the good news. The bad news was that the cobs were tiny, the 'runtish offspring' of an ... union, the 'ill-begotten children of [an] ... The kernels were equally stu... field was extrem...



- Model for cytogenetics.

Zea mays (corn)

Barbara McClintock and jumping genes

Next to McClintock's maize fields were the labs where Delbrück, Luria and their colleagues were running their phage course every summer. She got to know them pretty well, and

Homo sapiens

Humans: A model organism?

Model organisms. Why?

- Genome can be manipulated experimentally.
- Short life-cycle.
- Minimal living requirements.
- Small genome (some of them)!
- Easy to grow in lab.
- Small in size.
- Accumulated knowledge about the organism.
- Organism does NOT need to be BEAUTIFUL!!

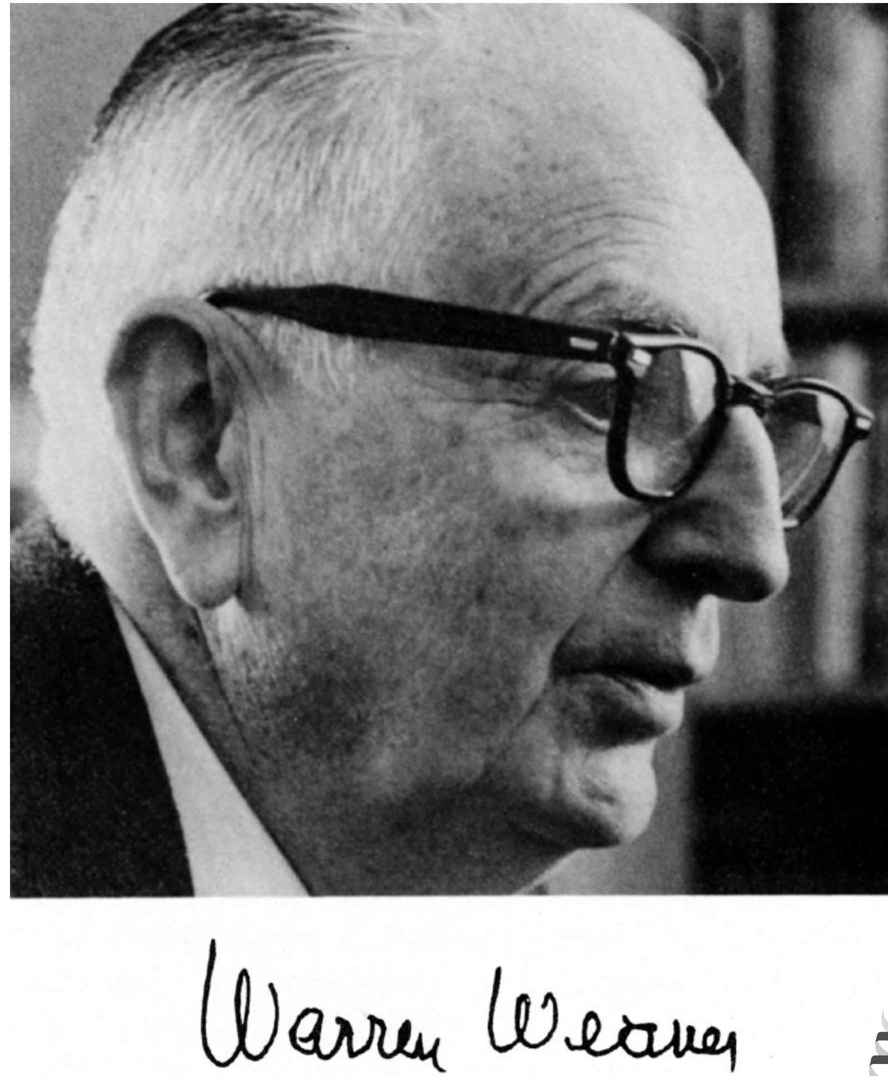
Molecular Biology

The biology of molecules

Sub-cellular biology

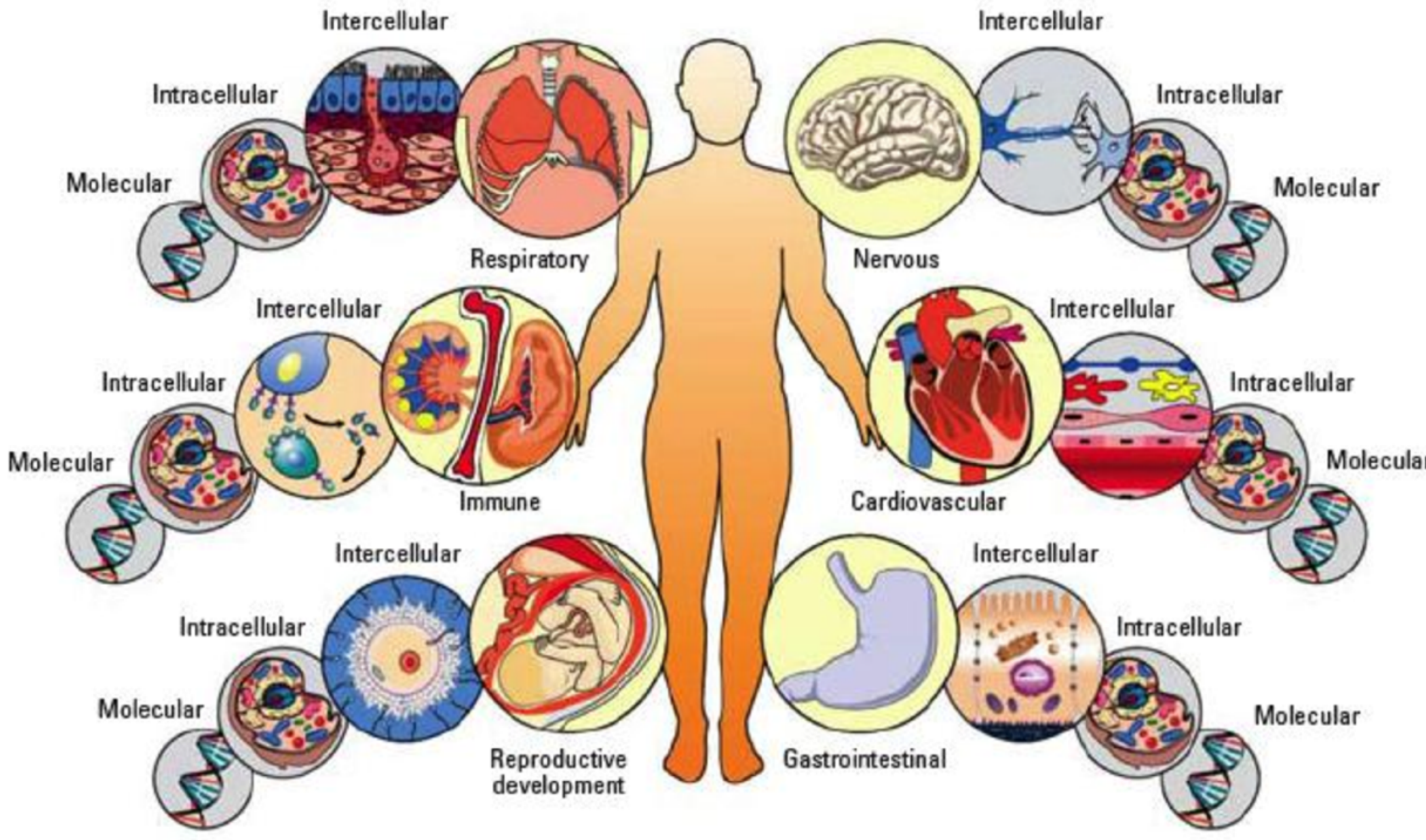
Molecular Biology

ray crystallography, and in 1938 it acquired a new name, 'molecular biology'. The name was coined by Warren Weaver, director of Rockefeller's Natural Sciences Division. He defined the field as the 'biology of molecules' or as 'sub-cellular biology', shifting from the cell itself as the object of study to a more fundamental level of analysis. Weaver made an explicit analogy with the sub-atomic world of the quantum physicists; to make



Why molecular biology is fun?

- Physical characters start with a molecule.
- Cognitive and emotional characters also start with a molecule (I think ☺).



To study

sexual life cycle

diploid

Eukaryotes

Arabidopsis thaliana
(plant)

Bacteriophage
(virus)

short life cycle

Zea mays
(corn)

Hermaphrodite

Danio rerio
(zebrafish)

prokaryotes

Saccharomyces cerevisiae
(budding yeast)

Mus musculus
(mouse)

Escherichia coli
(intestines' bacterium)

haploid

Homo sapiens
(Human)?

Asexual life cycle

Caenorhabditis elegans
(worm)

Drosophila melanogaster (fruit fly)

Expectations

- You know the importance of models in science.
- You know the most important model organisms.
- You know general characteristics of the model organisms.
- You know the taxonomic representation of each model organism.

For a smile

escherichia
CONJUGATION
16 NEW Antibiotic Resistances
for this summer!
special
does your host really love you?
TOP10 Animal Guts to colonize!
SEXY FLAGELLA
in only 10 days!
velica_2009