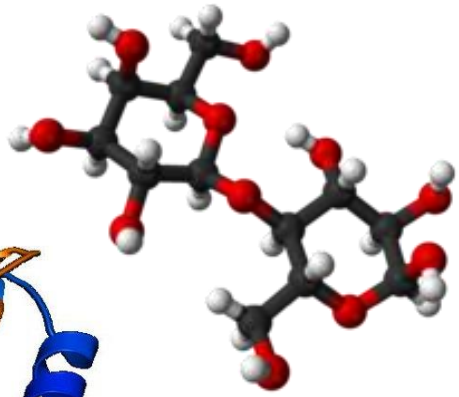
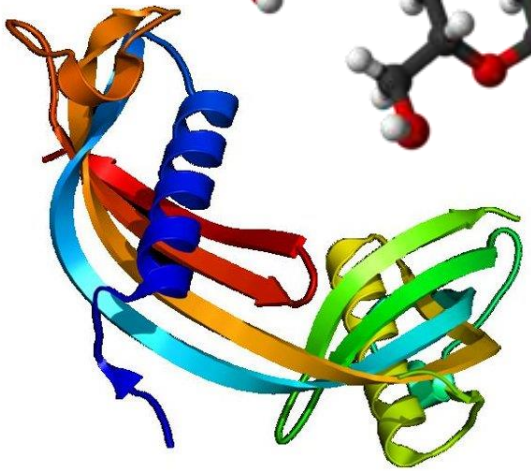
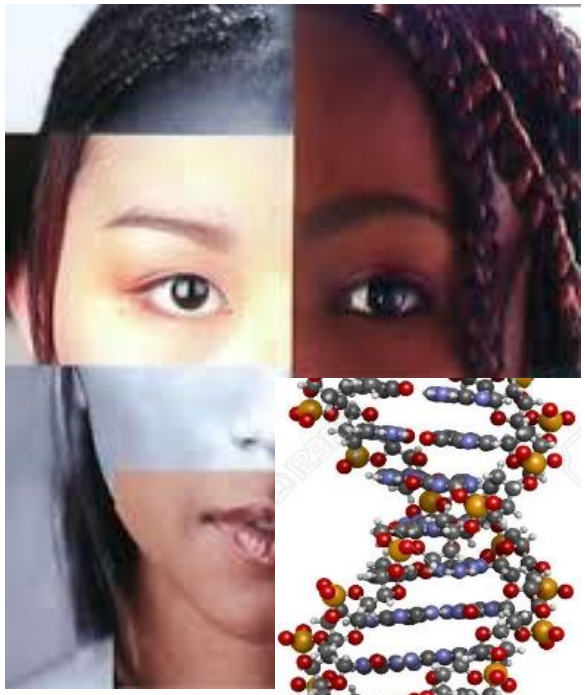
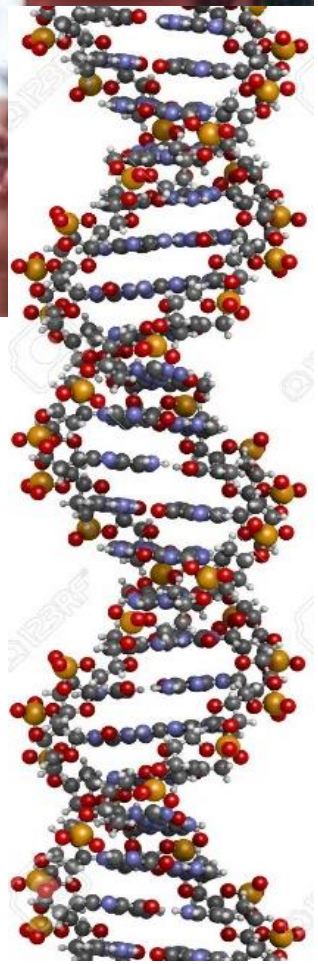
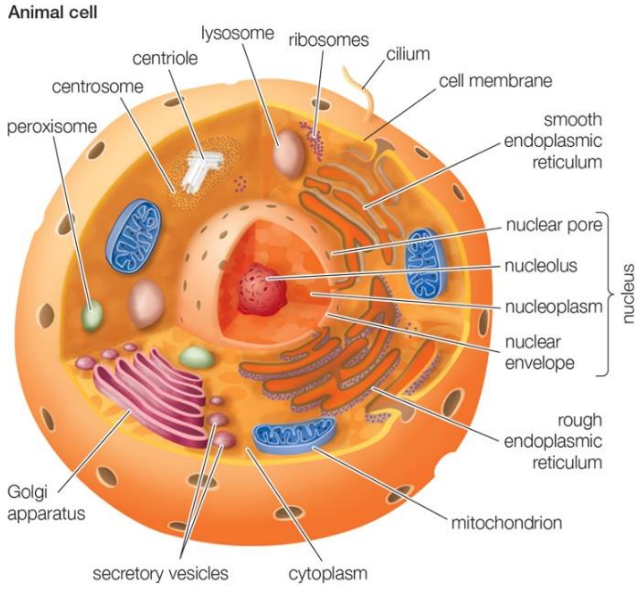


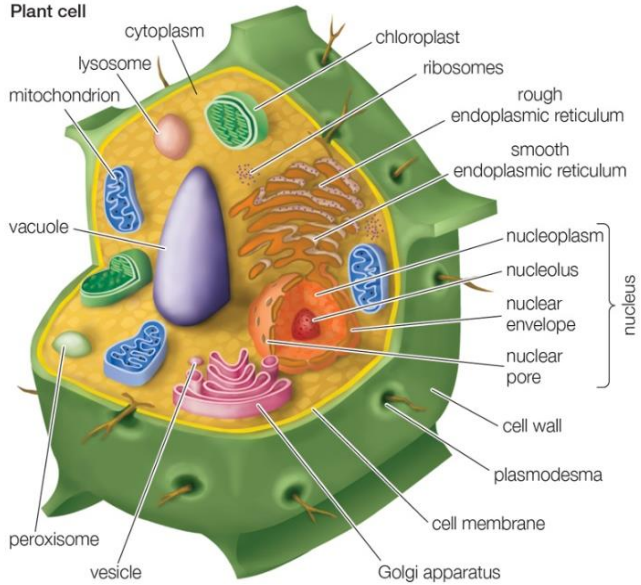




Inside Cells

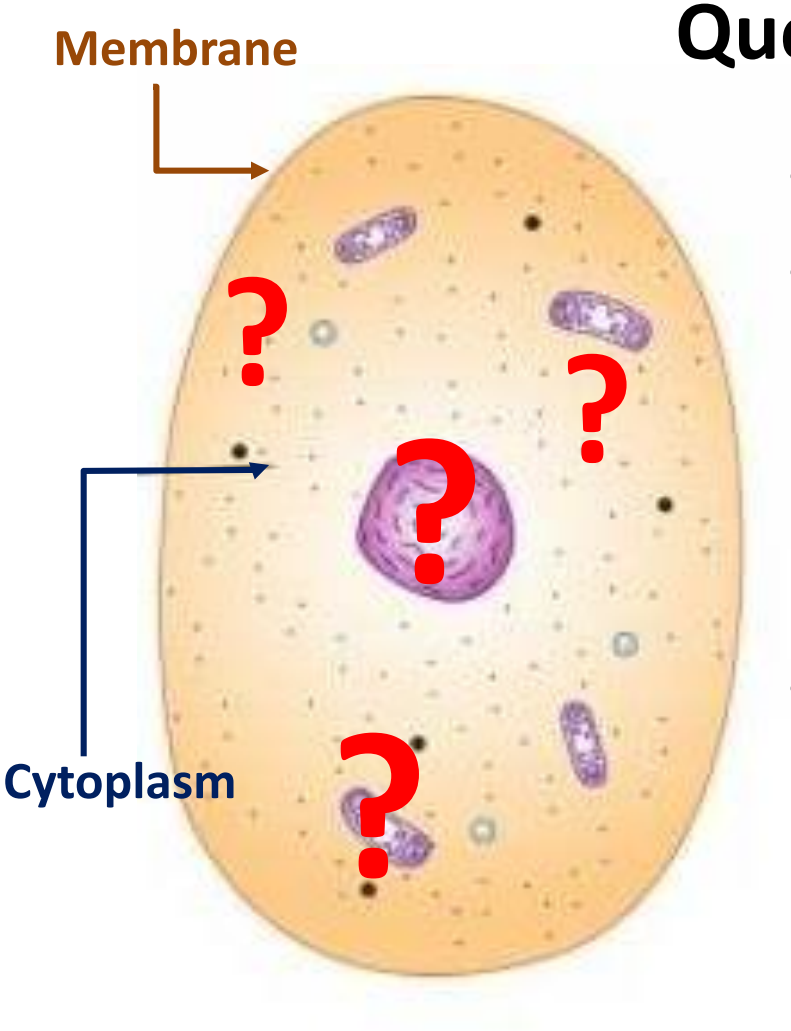






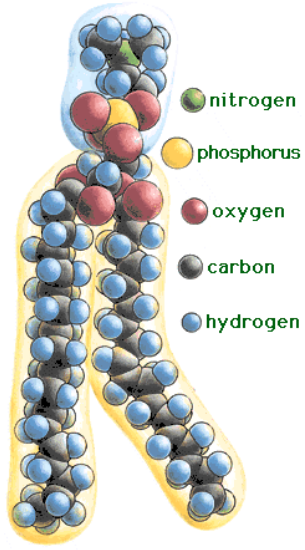
Cell Composition

All cells consist of a **cytoplasm** enclosed within a **membrane**.



Question: What's inside?

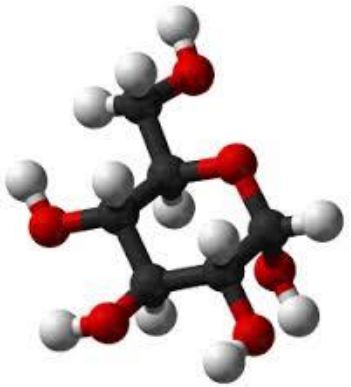
- **Organelles** – later☺
- **Cytoplasm** is composed of a mixture of small molecules (ions, amino acids, sugars and 70-90% water), and macromolecules which are essential to the cell's functions.
- Major classes of intracellular organic macromolecules:
  - ➢ Nucleic acids
  - ➢ Proteins
  - ➢ Carbohydrates
  - ➢ Lipids



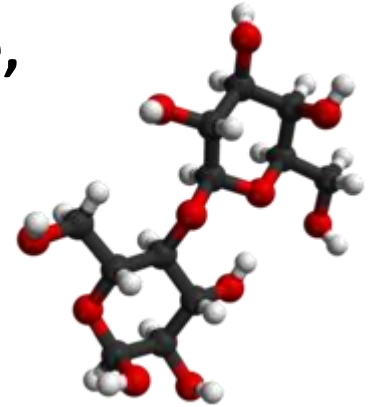
Lipids (Fat)

- **Lipids or *fat* molecules are components of cell membranes; they are also involved in energy storage, as well as relaying signals within cells.**

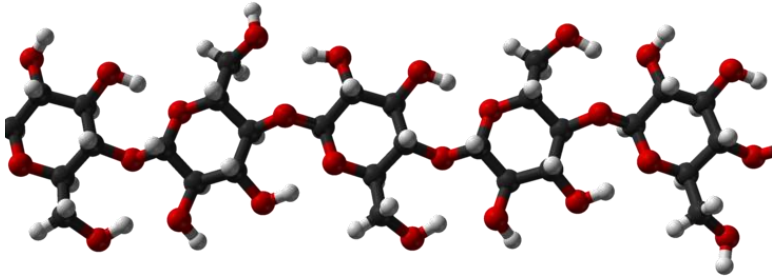
Carbohydrates



- **Simple carbohydrates (*sugars*) are used for the cell's immediate energy demands.**
- **Complex carbohydrates (p*olysaccharides*) can serve as intracellular energy stores (*starches* and *glycogen*) or have structural functions (*cellulose* and *chitin*); they are also found on a cell's surface, where they play a crucial role in cell recognition.**



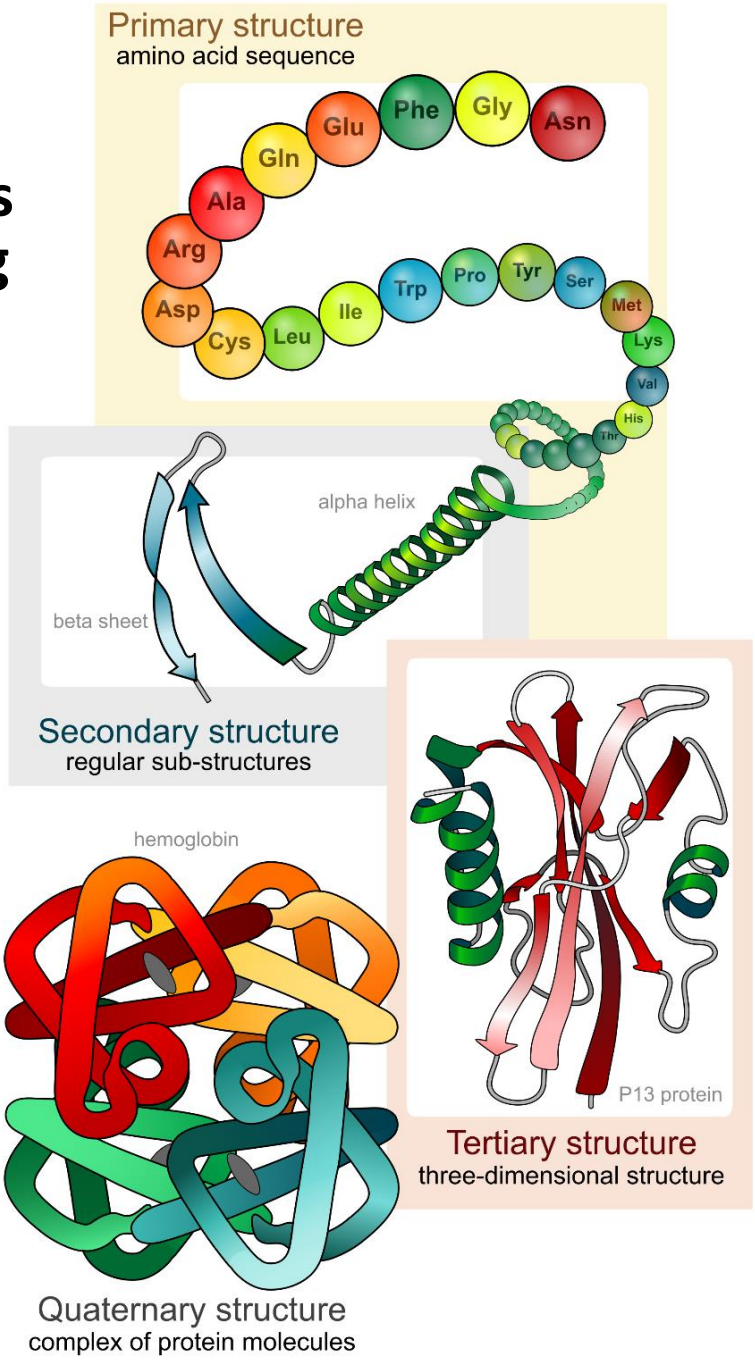
Hydrogen
Oxygen
Carbon



Proteins

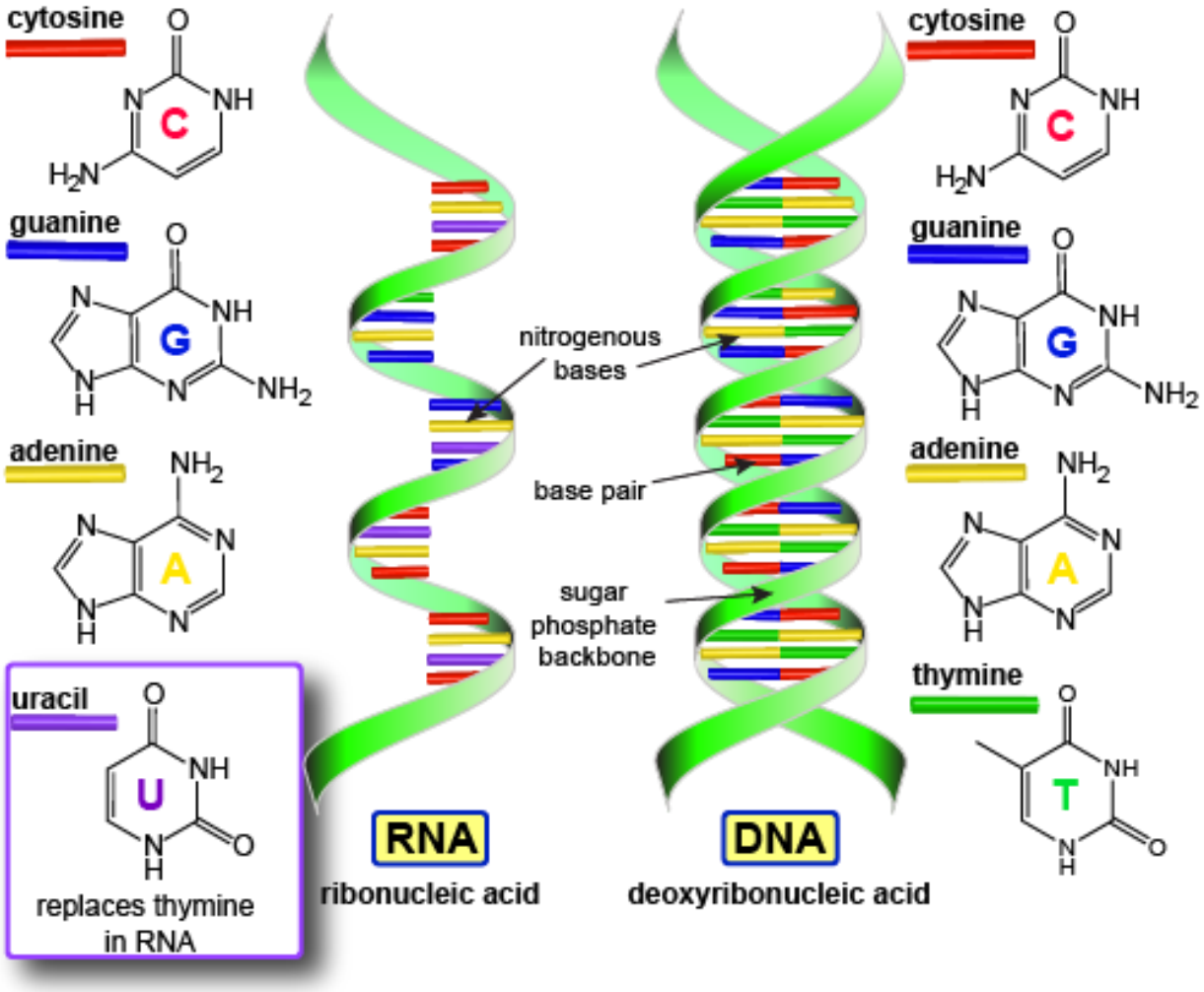
<u>Proteins</u> are the complex molecules that do most of the work in living organisms.

- **Made from chains of smaller molecules called amino acids.**
- **A protein is defined by the sequence of amino acids.**
- **Serve a variety of functions:**
  - **catalytic (*enzymes*) - almost all processes in the cell need help <u>speeding up</u> in order to occur at rates fast enough to sustain life**
  - **structural/mechanical**
- **Cells are capable of synthesizing (making) essential proteins.**



Nucleic Acids: Hereditary Material

All cells <u>store information</u> required to build and maintain the cell (*genetic information*) and <u>constantly use it</u>.



Nucleic acids are the molecules that

contain (Deoxyribonucleic acid, DNA)

and

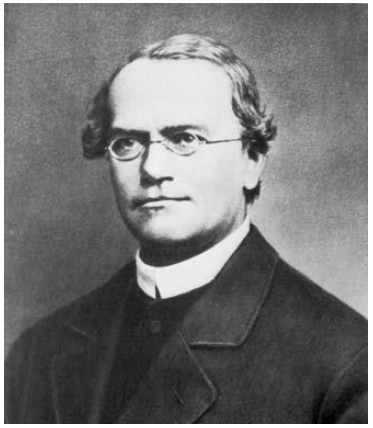
help express (ribonucleic acid, RNA)

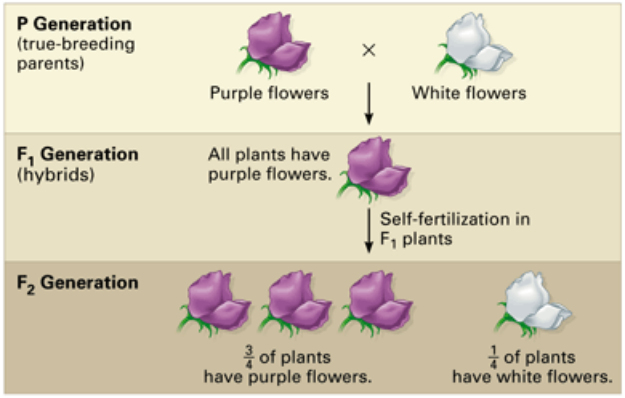
this information.

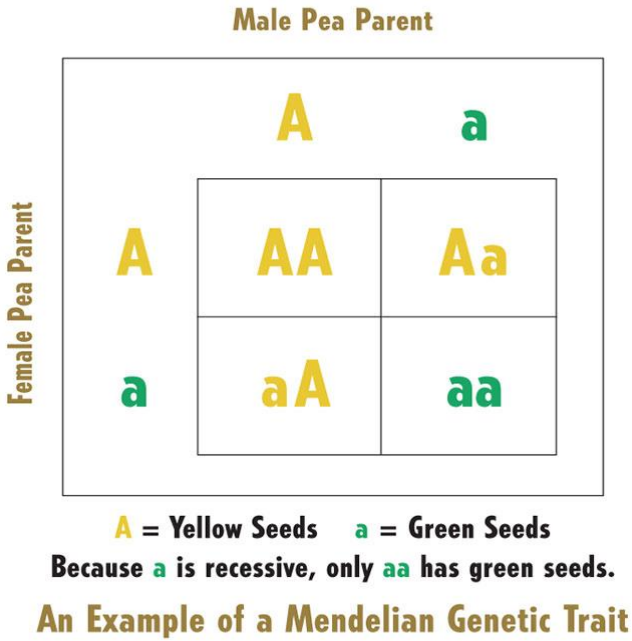
Laws of Mendelian Inheritance

Gregor Mendel, 1856-1863:

pea plant experiments



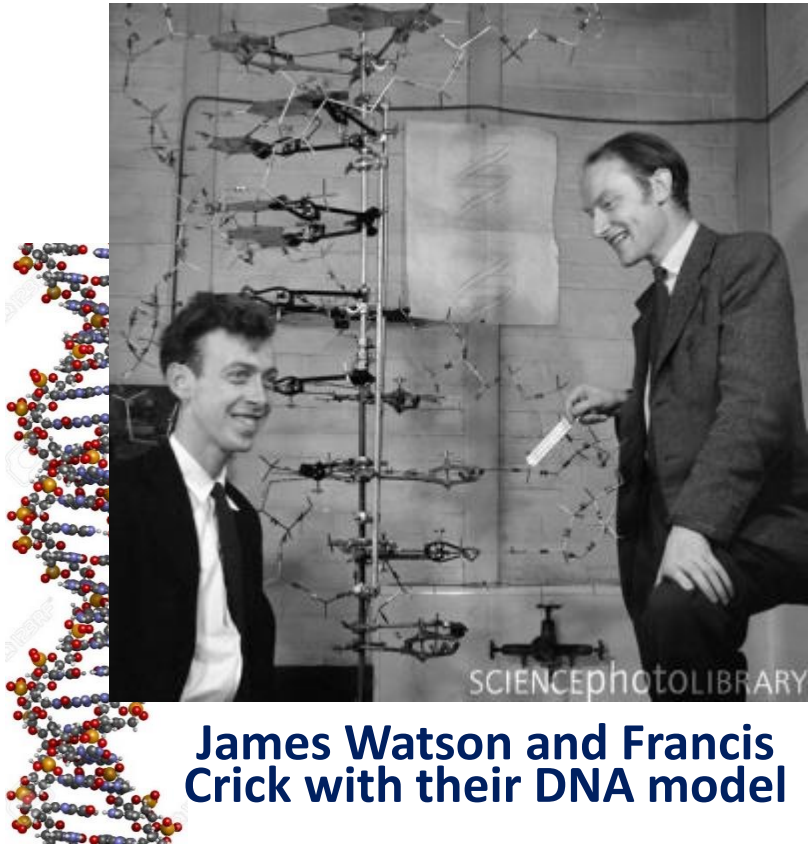




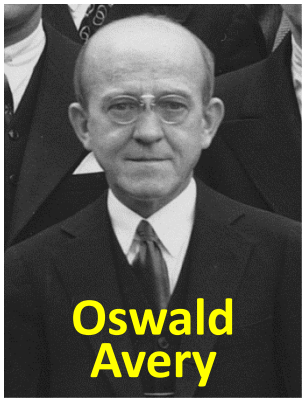
- **Cultivated and tested** some *29,000 pea plants* in the monastery's 2 hectares (4.9 acres) experimental garden.
- Worked with <u>seven characteristics</u>: plant height, pod shape and color, seed shape and color, and flower position and color.
- Law of Segregation: one random *allele* (gene variation) from each parent.
- Law of Independent Assortment: alleles for different traits are independent.
- Law of Dominance: some alleles are dominant while others are recessive; an organism with <u>at least one dominant</u> allele will <u>display the effect of the dominant</u> allele.
- **"Father of modern genetics"**

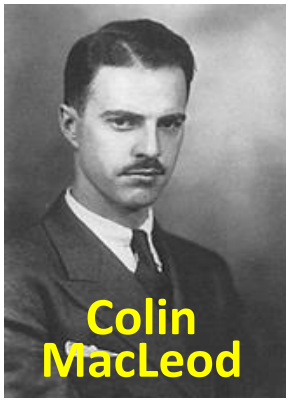
DNA Discovery

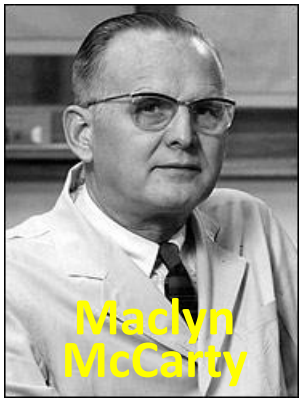
- Swiss physician Friedrich Miescher discovered DNA ("nuclein") in 1869, athough scientists did not understand what it was until…



James Watson and Francis Crick with their DNA model







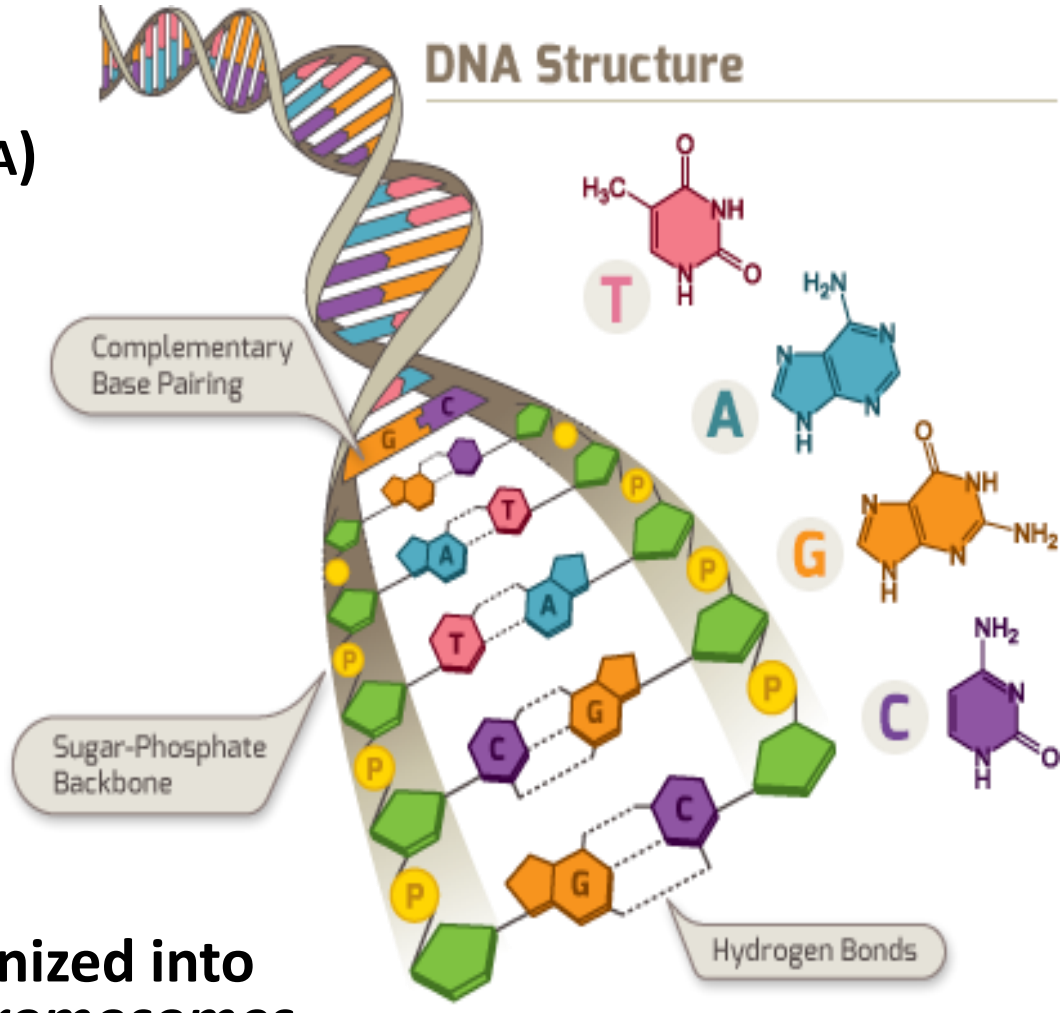
…1943: Avery-MacLeod-McCarty experiment showed that DNA is the hereditary material in bacteria.

- In 1953, James Watson and Francis Crick suggested the double-helix model of DNA structure based on a single X-ray diffraction image.

DNA

DNA is a long polymer made from repeating units called nucleotides, or *bases*.

- **Four types of bases:**
  - **T - Thymine (Uracil in RNA)**
  - **A - Adenine**
  - **G - Guanine**
  - **C - Cytosine**
- **In living organisms DNA does not usually exist as a single molecule, but instead as a pair of molecules that are held tightly together, entwined in the shape of a double helix.**
- **Within cells, DNA is organized into long structures called *chromosomes*.**



Genome and Genetic Code

What is Genome?

- Genetic material of an organism, essentially the instructions on making proteins and RNAs.
- Inscribed in DNA: complete DNA sequence.
- Includes both the *genes* and the non-coding regions.

What is Gene?

- The portion of the genome that codes for a single protein or an RNA.
- The molecular unit of heredity of a living organism.
- The size of a single gene may vary greatly, ranging from ~1,000 bases to ~1 million bases in humans.

What is Genetic Code?

- The set of rules by which information encoded within DNA or RNA is translated into proteins.
- In general, the genetic code specifies 20 standard amino acids by means of triple nucleotide *codons* and is basically the same for all organisms on Earth.

Human DNA

- The Human Genome Project (1990-2003) produced the first complete sequences of individual human genomes.
- Human genome contains ~3 billion bases and ~20,500 genes.
- Over 98% of the human DNA comprises non-coding repetitive sequences (the role, functions and descriptions of these sequences are currently being investigated by scientists).

- By 2012, thousands of human genomes have been completely sequenced.
- All humans have the DNA that is 99.9% similar, however the rest 0.01% is enough to identify different individual DNA sequences (*i.e. tell apart which DNA belongs to whom*).
- Primary (and now standard routine!) applications include paternity testing as well as DNA profiling in criminal investigations.

DNA Half-Life

In 2012, researchers have calculated that DNA from bones has a 521 year half-life, which means that the oldest clone-able samples of DNA could be no more than 2 million years old.

This result rules out any possibility of ever replicating dinosaurs, as the youngest dinosaurs were around more than 65 million years ago…