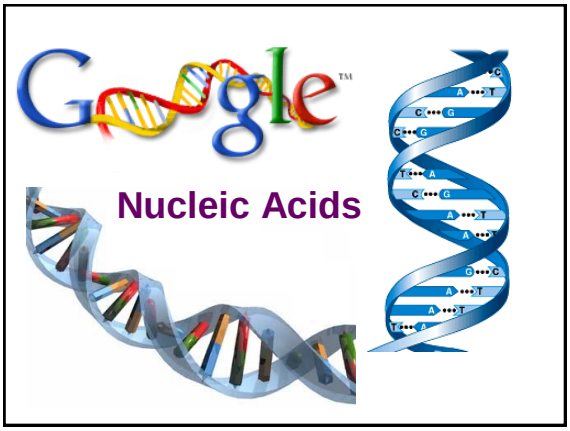
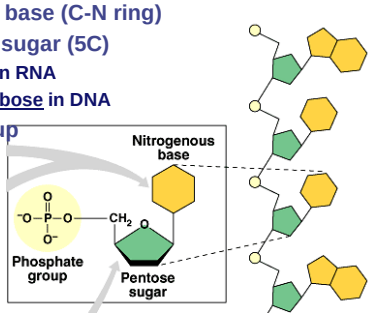


Nucleic Acids

- **Function:**
  - store & transmit hereditary information
- **Examples:**
  - RNA (ribonucleic acid)
  - DNA (deoxyribonucleic acid)
- **Structure:**
  - monomers = nucleotides

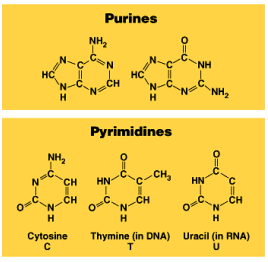
Nucleotides

- **3 parts**
  - nitrogen base (C-N ring)
  - pentose sugar (5C)
    - ribose in RNA
    - deoxyribose in DNA
  - PO_4 group

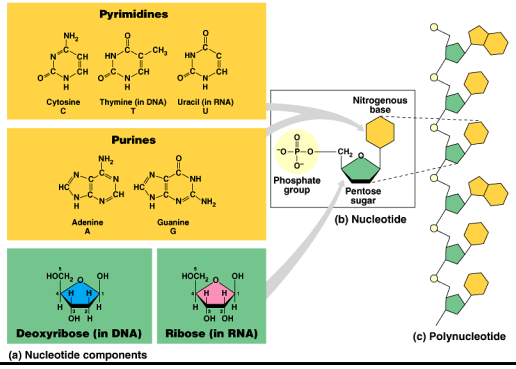


Types of Nucleotides

- **2 types of nucleotides**
  - based on different nitrogenous bases
  - purines
    - double ring N base
    - adenine (A)
    - guanine (G)
  - pyrimidines
    - single ring N base
    - cytosine (C)
    - thymine (T)
    - uracil (U)

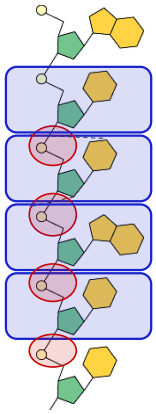


Building the Polymer



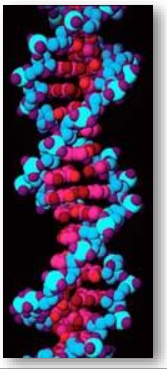
Nucleic Polymer

- **Backbone**
  - sugar to PO_4 bond
  - phosphodiester bond
    - a COVALENT bond
    - new base added to sugar of previous base
    - polymer grows in one direction
  - N bases hang off the sugar-phosphate backbone



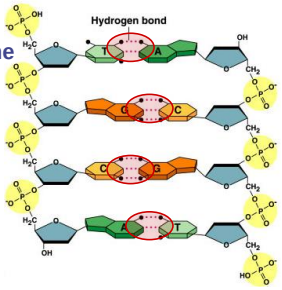
Nucleic Acid Types

- RNA
  - single nucleotide chain
- DNA
  - double nucleotide chain
    - N bases bond in pairs across chains
  - spiraled in a double helix
    - double helix 1st proposed as structure of DNA in 1953 by James Watson & Francis Crick



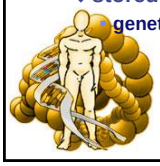
Pairing of Nucleotides

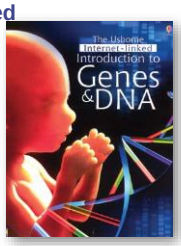
- Nucleotides bond between DNA strands
  - H bonds
  - purine :: pyrimidine
  - A :: T
    - 2 H bonds
  - G :: C
    - 3 H bonds

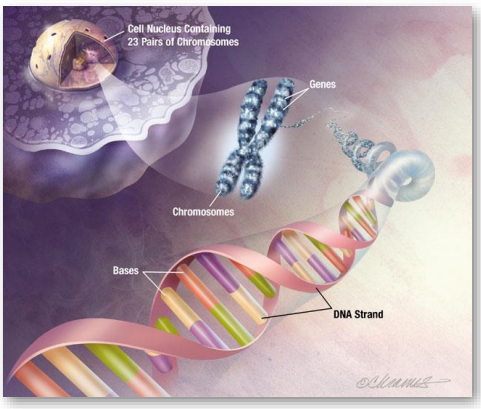


Information Polymer

- Function
  - series of bases encodes information
    - like the letters of a book
  - stored information is passed from parent to offspring
    - need to copy accurately
  - stored information = genes
    - genetic information



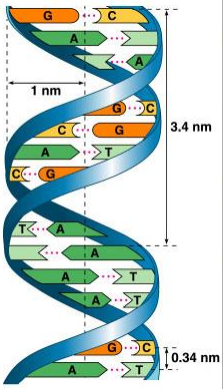




DNA Molecule

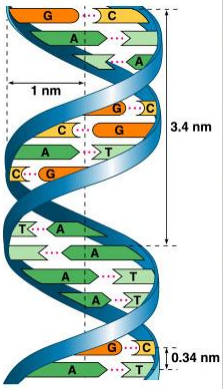
- Double helix
  - H bonds between bases join the 2 strands
    - A :: T
    - C :: G

Again – understand the significance of the hydrogen bonds *between* strands!



Copying DNA

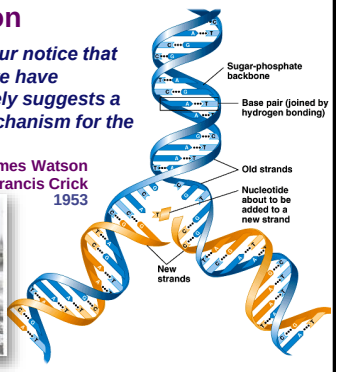
- Replication
  - 2 strands of DNA helix are complementary
    - have one, can build other
    - have one, can rebuild the whole
  - why is this a good system?
  - when in the life of a cell does replication occur?
    - mitosis
    - meiosis



DNA Replication

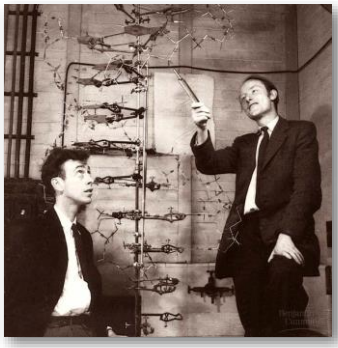
"It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material."

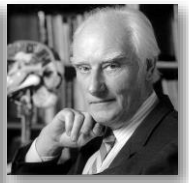
James Watson
Francis Crick
1953



Watson and Crick. with others…

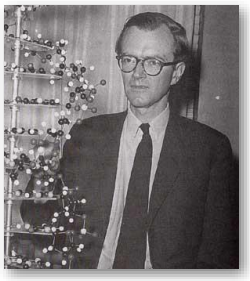
1953 | 1962



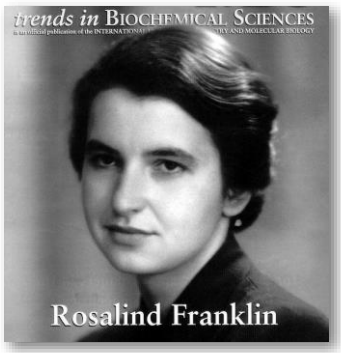


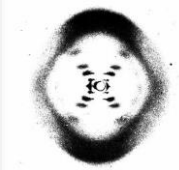
Maurice Wilkins. and…

1953 | 1962



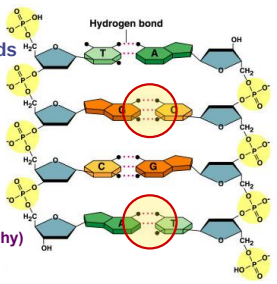
Rosalind Franklin (1920-1958)





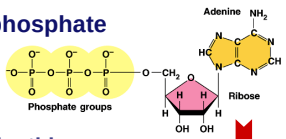
Interesting note…

- Ratio of A-T::G-C affects stability of DNA molecule
  - 2 H bonds vs. 3 H bonds
  - biotech procedures
    - more G-C = need higher T° to separate strands
  - high T° organisms
    - many G-C
  - parasites
    - many A-T (don't know why)

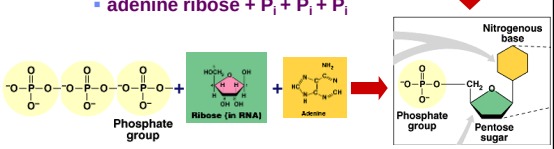


Another interesting note…

- ATP: Adenosine Triphosphate

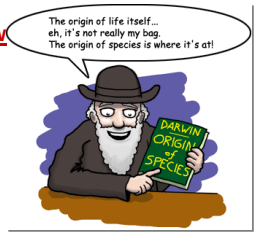


  - modified nucleotide
    - adenine ribose + P_i + P_i + P_i



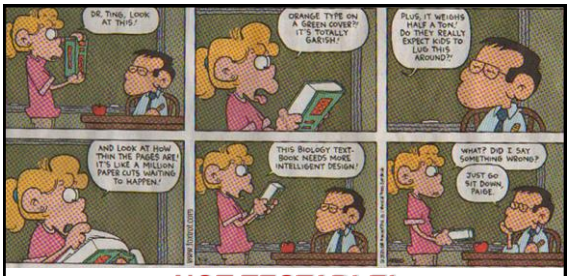
What is Life?

- First we have to define LIFE…
  - organized as cells
  - respond to stimuli
  - regulate internal processes
    - homeostasis
  - use energy to grow
    - metabolism
  - develop
    - change & mature within lifetime
  - reproduce
    - heredity
      - DNA / RNA
    - adaptation & evolution



The Origin of Life is Hypothesis?

- Special Creation
  - *Was life created by a supernatural or divine force?*
  - not testable



NOT TESTABLE!

The Intelligent Design movement "does not provide things that are refutable" because its real objective is not to prove a scientific theory but to gain ground for religious ideology.

Why Darwin Matters: Michael Shermer

The Origin of Life is Theory!

- Special Creation
  - *Was life created by a supernatural or divine force?*
  - not testable
- Extraterrestrial Origin
  - *Was the original source of organic (carbon) materials comets & meteorites striking early Earth?*
  - testable
- Spontaneous Abiotic Origin
  - *Did life evolve spontaneously from inorganic molecules?*
  - testable

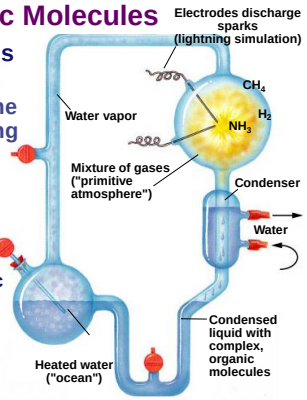
Conditions on early Earth

- Reducing atmosphere
  - water vapor (H_2O), CO_2, N_2, NO_x, H_2, NH_3, CH_4, H_2S
  - lots of available H & its electron
  - no free oxygen
- Energy source
  - lightning, UV radiation, volcanic

low O_2 = organic molecules do not breakdown as quickly

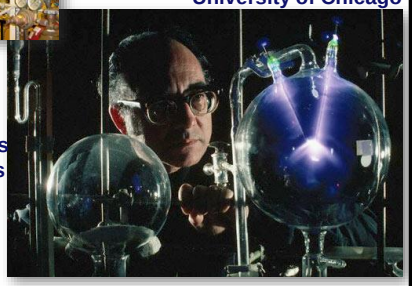
Origin of Organic Molecules

- Abiotic synthesis
  - 1920 Oparin & Haldane propose reducing atmosphere hypothesis
  - 1953 Miller & Urey test hypothesis
    - formed organic compounds
      - amino acids
      - adenine



Stanley Miller

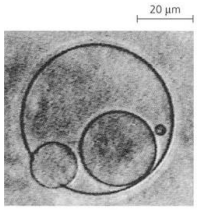
University of Chicago



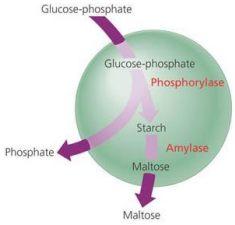
produced:
- amino acids
- hydrocarbons
- nitrogen bases
- other organics

Origin of Cells (protobionts)

- Bubbles → separate inside from outside
  → metabolism & reproduction



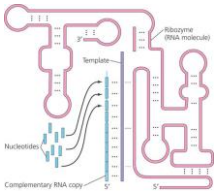
(a) Simple reproduction. This liposome is "giving birth" to smaller liposomes (LM).



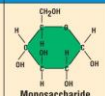
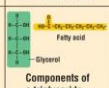
(b) Simple metabolism. If enzymes—in this case, phosphorylase and amylase—are included in the solution from which the droplets self-assemble, some liposomes can carry out simple metabolic reactions and export the products.

Origin of Genetics — Dawn of natural selection

- RNA is likely first genetic material
  - multi-functional
  - codes information
    - self-replicating molecule THAT CAN MUTATE
    - makes inheritance possible
    - natural selection & evolution
  - enzyme functions
    - ribozymes
    - replication
  - regulatory molecule
  - transport molecule
    - tRNA

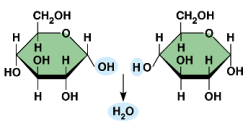


Macromolecule Review

Biological macromolecule	Function	Monomer	Examples
Carbohydrates	Dietary energy; storage; plant structure	 Monosaccharide	Monosaccharides: glucose, fructose. Disaccharides: lactose, sucrose. Polysaccharides: starch, cellulose.
Lipids	Long-term energy storage (for fats); hormones (for steroids)	 Components of a triglyceride	Fats, oils, steroids
Proteins	Enzymes, structure, storage, contraction, transport, etc.	 Amino acid	Lactase (an enzyme), hemoglobin
Nucleic acids	Information storage	 Nucleotide	DNA, RNA

Carbohydrates

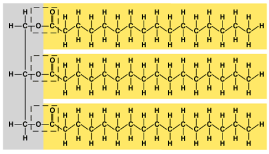
- Structure / monomer
  - monosaccharide
- Function
  - energy
  - raw materials
  - energy storage
  - structural compounds
- Examples
  - glucose, starch, cellulose, glycogen



glycosidic bond

Lipids

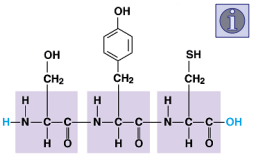
- **Structure / building block**
  - glycerol, fatty acid, cholesterol, H-C chains
- **Function**
  - energy storage
  - membranes
  - hormones
- **Examples**
  - triglycerides, phospholipids, steroids



ester bond (in a fat)

Proteins

- **Structure / monomer**
  - amino acids
  - levels of structure
- **Function**
  - enzymes
  - transport
  - signals
  - defense
  - structure
  - receptors
- **Examples**
  - digestive enzymes, membrane channels, insulin hormone, actin



peptide bond

Nucleic acids

- **Structure / monomer**
  - nucleotide
- **Function**
  - information storage & transfer
- **Examples**
  - DNA, RNA

phosphodiester bond