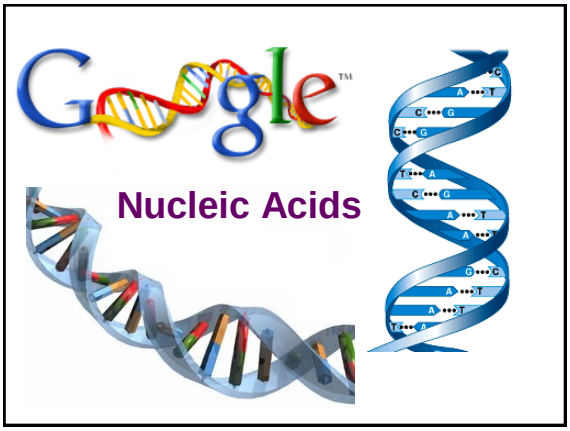
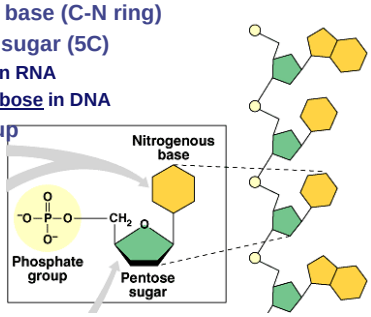


Nucleic Acids

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

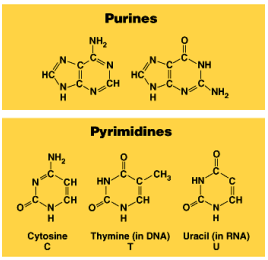
Nucleotides

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

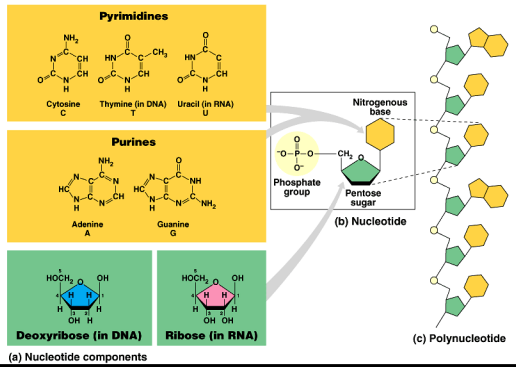


Types of Nucleotides

- **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)

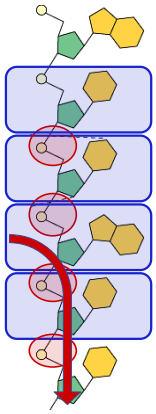


Building the Polymer



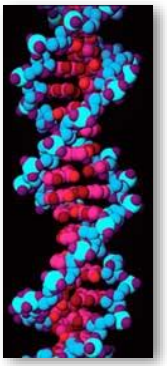
Nucleic Polymer

- **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



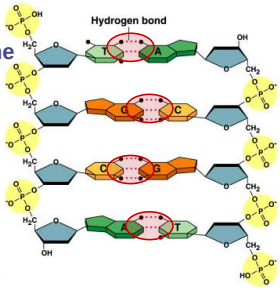
Nucleic Acid Types

- 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



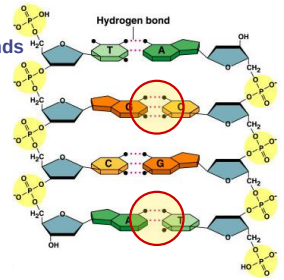
Pairing of Nucleotides

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



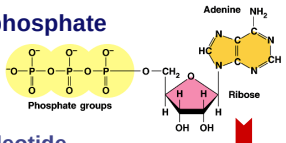
Interesting note…

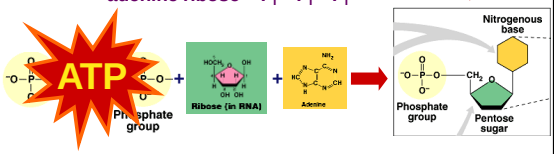
- Ratio of A-T::G-C affects stability of DNA molecule
  - 2 H bonds vs. 3 H bonds
  - biotech procedures
    - more G-C bonds need higher T° to separate strands
  - high T° organisms
    - many G-C



Another interesting note…

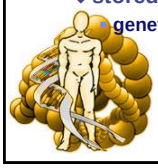
- ATP: Adenosine Triphosphate
  - modified nucleotide
    - adenine ribose + P_i + P_i + P_i

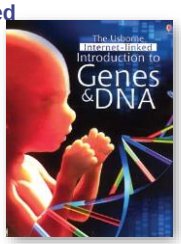




Information Polymer

- 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

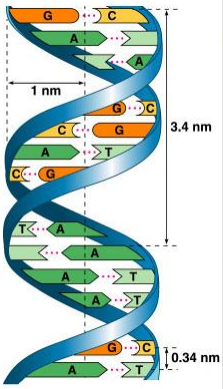




DNA Molecule

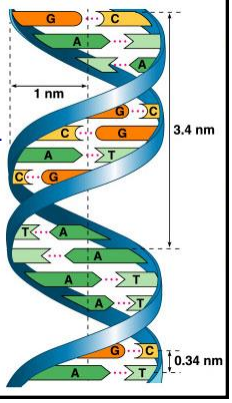
- Double helix
  - H bonds between bases join the 2 strands
    - A :: T
    - C :: G

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



Copying DNA

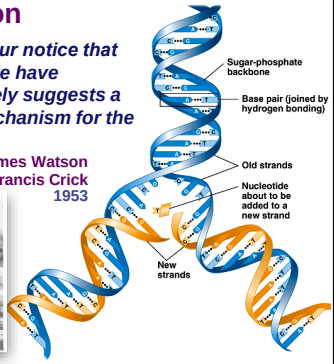
- Replication
  - 2 strands of DNA helix are complementary
    - have one, can build other
    - have one, can rebuild the whole
  - why is this a good system?
  - when in the life of a cell does replication occur?
    - mitosis
    - meiosis



DNA Replication

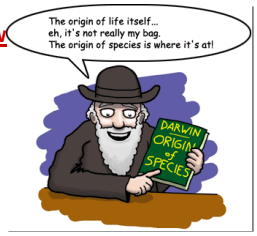
"It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material."

James Watson
Francis Crick
1953



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 Theory!

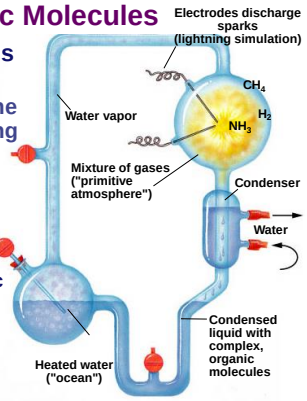
- Special Creation
  - *Was life created by a supernatural or divine force?*
  - not testable
- Extraterrestrial Origin
  - *Was the original source of organic (carbon) materials comets & meteorites striking early Earth?*
  - testable
- Spontaneous Abiotic Origin
  - *Did life evolve spontaneously from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

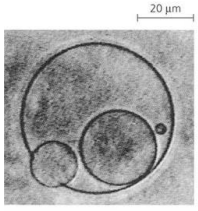
Origin of Organic Molecules

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

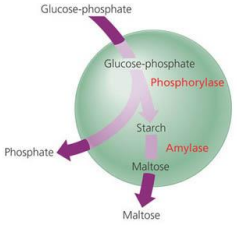


Origin of Cells (protobionts)

- Bubbles → separate inside from outside
  → metabolism & reproduction



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

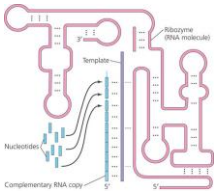


(b) **Simple metabolism.** If enzymes—in this case, phosphorylase and amylase—are included in the solution from which the droplets self-assemble, some liposomes can carry out simple metabolic reactions and export the products.

Origin of Genetics

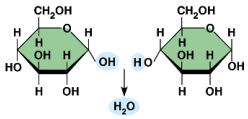
Dawn of natural selection

- 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



Carbohydrates

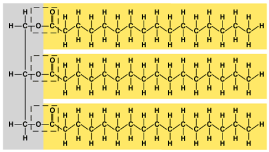
- Structure / monomer
  - monosaccharide
- Function
  - energy
  - raw materials
  - energy storage
  - structural compounds
- Examples
  - glucose, starch, cellulose, glycogen



glycosidic bond

Lipids

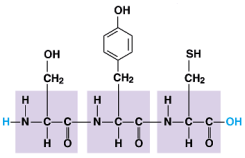
- Structure / building block
  - glycerol, fatty acid, cholesterol, H-C chains
- Function
  - energy storage
  - membranes
  - hormones
- Examples
  - triglycerides, phospholipids, steroids



ester bond (in a fat)

Proteins

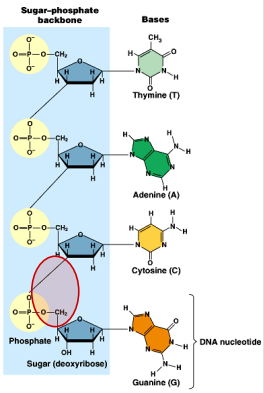
- Structure / monomer
  - amino acids
  - levels of structure
- Function
  - enzymes
  - defense
  - transport
  - structure
  - signals
  - receptors
- Examples
  - digestive enzymes, membrane channels, insulin hormone, actin



peptide bond

Nucleic acids

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



phosphodiester bond