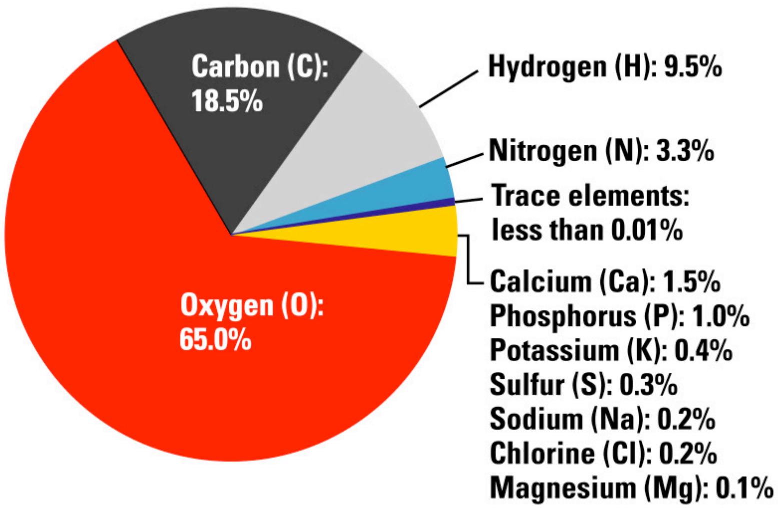
The Nature of Biology

A Little Biochemistry (*very little*.)

- Twenty-five elements are essential to life.
  - Four of these **(O, C, H, N)** make up about 96% of the weight of the human body.
  - Trace elements occur in smaller amounts.



The Nature of Biology

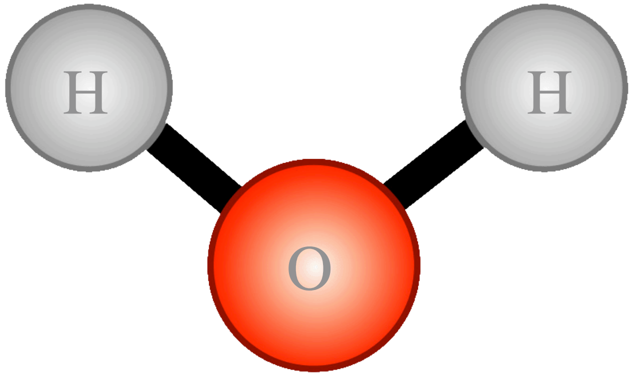
A Little Biochemistry (*very little*.)

- Water, water everywhere.
  - Life on Earth began in water & evolved there for over 3 billion years.
    - Modern life still remains tied to water.
    - Cells are composed of 70%–95% water.

The Nature of Biology

A Little Biochemistry (*very little*.)

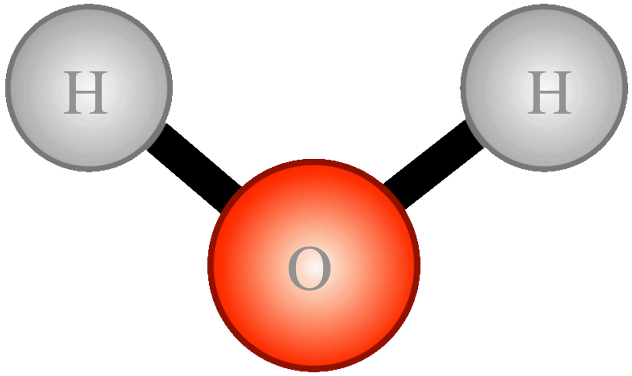
- Water's life-supporting properties:
  - Cohesive nature
  - Ability to moderate temperature
  - Floating ice
  - Versatility of water as a solvent



The Nature of Biology

Water, water everywhere …

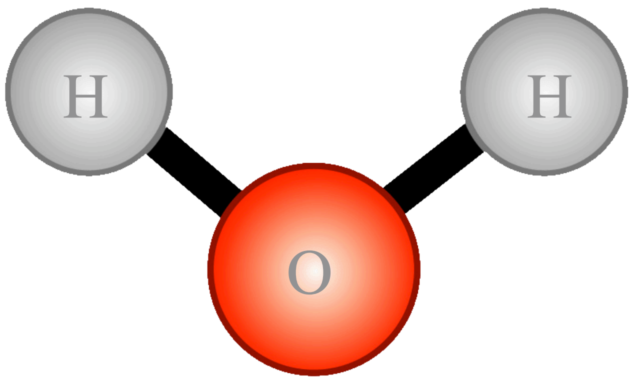
- Water's cohesive nature.
  - Water molecules "stick" together as a result of hydrogen bonding.
    - This is called cohesion.
    - Cohesion is vital for water transport in plants.
  - Hydrogen bonds give water an unusually high surface tension.
    - Surface tension is the measure of how difficult it is to stretch or break the surface of a liquid.



The Nature of Biology

Water, water everywhere …

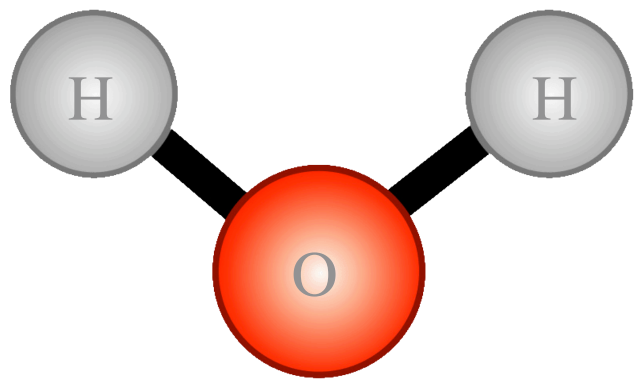
- Water can moderate temperatures
  - Earth's giant water supply causes temperatures to stay within limits that permit life.
  - Evaporative cooling removes heat from the Earth & from organisms.



The Nature of Biology

Water, water everywhere …

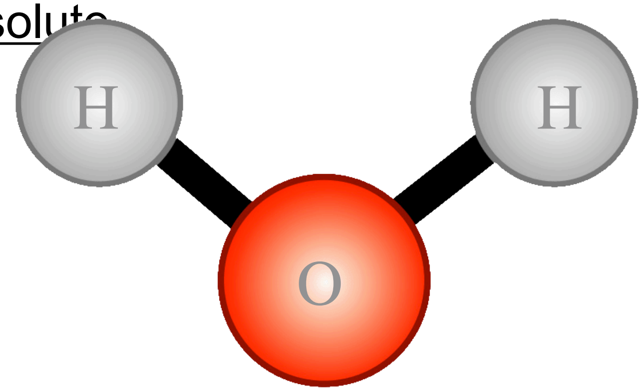
- Floating Ice
  - Since ice floats, ponds, lakes, and even the oceans do not freeze solid.
  - Marine life could not survive if bodies of water froze solid.



The Nature of Biology

Water, water everywhere …

- The Universal Solvent
  - A solution is a liquid consisting of two or more substances evenly mixed.
  - The dissolving agent is called the solvent.
  - The dissolved substance is called the solute.
  - When water is the solvent, the result is called an aqueous solution.

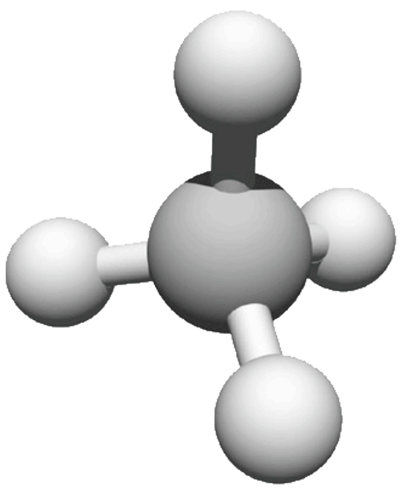


The Nature of Biology

Organic Chemistry

- Although a cell is mostly water, the rest of the cell consists mostly of carbon-based molecules.

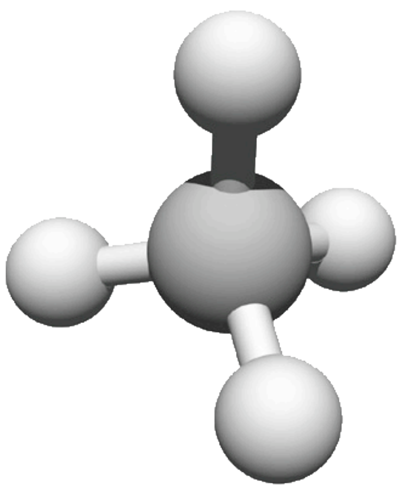
- Organic chemistry is the study of carbon compounds.



The Nature of Biology

We are organic life-forms.

- The versatile carbon (C) atom.
- Carbon can bond to itself in an almost limitless combination of straight or branched chains.

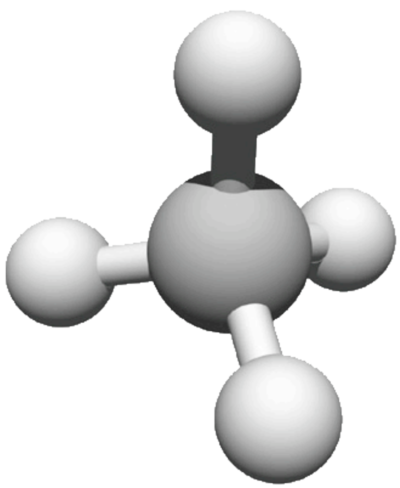


- Form an infinite number of compounds.
- No other element can do so.

The Nature of Biology

The simplest organic compounds are <u>hydrocarbons</u>.

- These are organic molecules containing only carbon and hydrogen atoms.

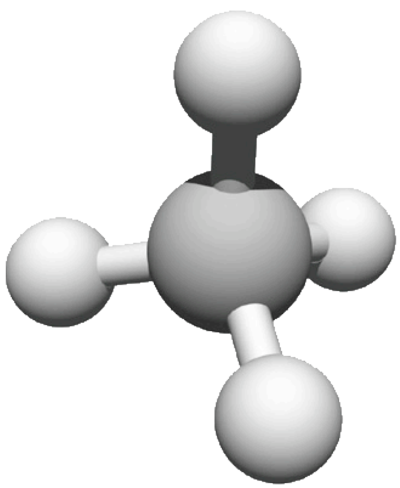


- Example of simple hydrocarbons: *methane (CH_4).*
- Complex: *gasoline*.
- The hydrocarbons of fat molecules provide energy for our bodies.

The Nature of Biology

3-D shape defines organic molecule function.

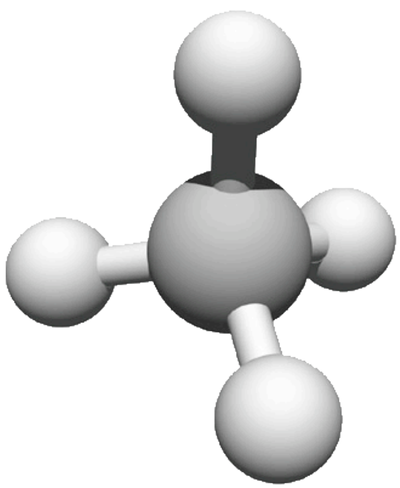
- Each type of organic molecule has a unique 3-D shape that defines its function in an organism.
- The molecules of your body recognize one another based on their shapes.

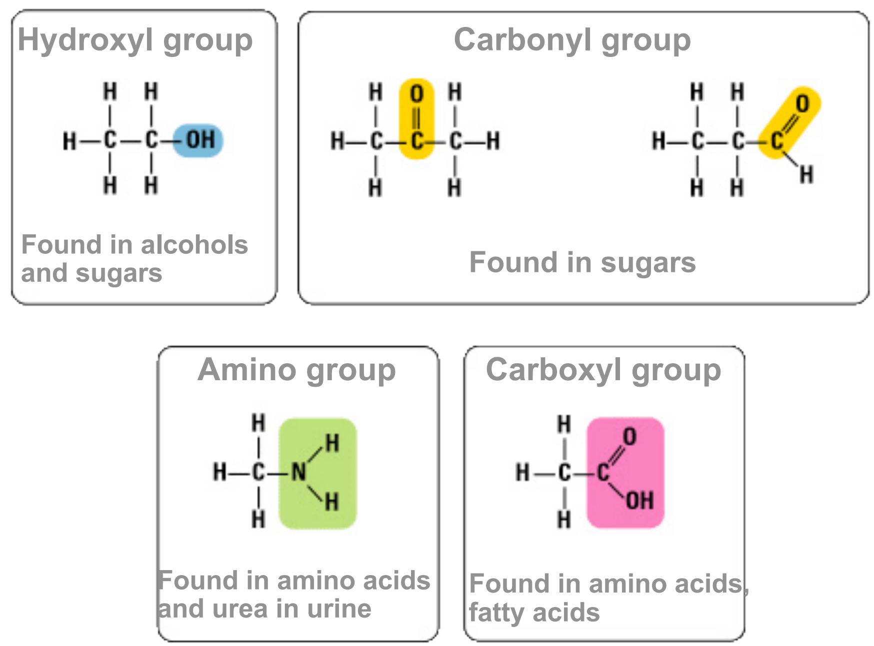


The Nature of Biology

3-D shape defines organic molecule function.

- The unique properties of an organic compound depend not only on its carbon skeleton but also on atoms attached to the skeleton called functional groups.

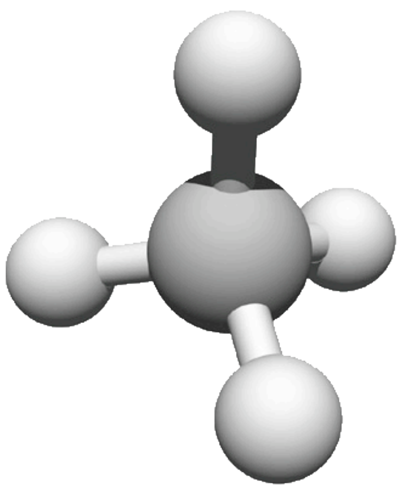




The Nature of Biology

Giant Molecules.

- On a molecular scale, many of life's molecules are gigantic.
  - Biologists call them macromolecules.
  - Examples: *proteins, DNA*



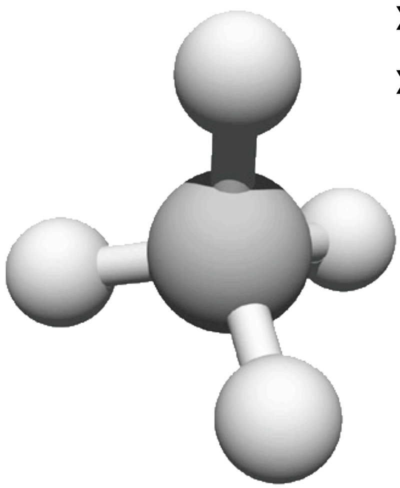
- Most macromolecules are polymers.
  - Polymers are made by stringing together many smaller molecules called monomers.

The Nature of Biology

Biological Molecules.

- There are four categories of large molecules in cells.

  » Carbohydrates
  » Lipids
  » Proteins
  » Nucleic acids



The Nature of Biology

Watch those carbs.

- Carbohydrate function:
  - Structural components of cells
  - Source of energy
  - Protective covering (example: *chitin*)
  - Essential constituents of important molecules (example: *pentose in nucleic acids*)

The Nature of Biology

Watch those carbs.

- Carbohydrates include:
  - *Monosaccharides* - simple (single) sugars like:
    - Glucose (sports drinks)
    - Fructose (fruit)
  - *Disaccharide* - double sugars like:
    - Sucrose (table sugar) - glucose + fructose
    - Lactose (milk sugar) - glucose + galactose
  - *Polysaccharides* - large (complex) carbohydrates
    - Starches like pasta & potatoes

The Nature of Biology

Watch those carbs.

- Example of polysaccharides:
  - Starch
    - Plant cells store starch for energy.
  - Glycogen
    - Animals store excess sugar in this form.
  - Cellulose (most abundant organic compound)
    - Forms cable-like fibrils in the tough walls that enclose plants.
    - Major component of wood.
    - Also known as dietary fiber.

The Nature of Biology

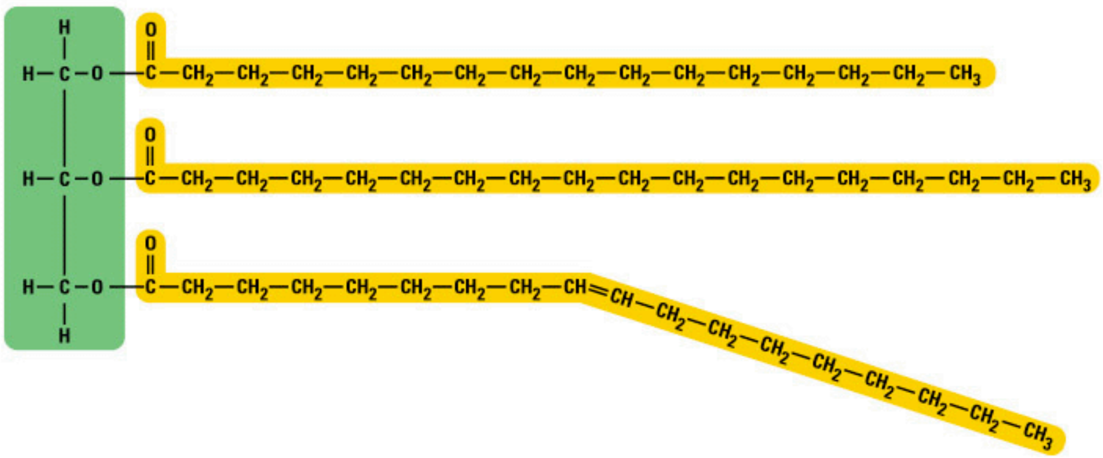
Lipids.

- Lipid function:
  - Food / energy reserve
  - Cell boundaries
  - Waterproofing, cushion, insulators (example: *waxes*)
  - Chemical messengers (example: *steroids*)
- Lipid characteristics:
  - Hydrophobic (do not mix with water)

The Nature of Biology

Lipids.

- Fat Molecules
  - Dietary fat consists largely of the molecule triglyceride.
    - A combination of glycerol & three fatty acids.



The Nature of Biology

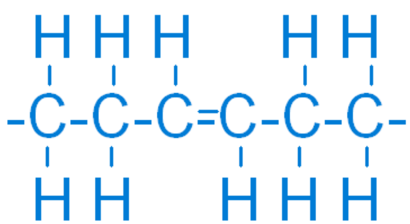
Lipids.

- Cholesterol
  - Needed to maintain fluidity of cell membrane
  - Associated with cardiovascular disease (‘clogged arteries’)
  - Synthesized internally
- Saturated fats (single bonds) decrease the fluidity of cell membranes by packing too tightly together
  - lard, butter and cream contain saturated fats
- Unsaturated fats (double bonds) keep membranes more flexible & are less easily converted into cholesterol
  - polyunsaturated fats are believed to lower cholesterol
  - omega-6 fatty acids (safflower, sunflower, and soybean oils)
  - omega-3 fatty acids (fish and flax oils)

The Nature of Biology

Lipids.

- *Trans* fats
  - Type of unsaturated fat
  - Most trans fats chemically created by partially hydrogenating plant oils
  - solid at room temperature, but melts upon baking (or eating).
  - extends shelf-life



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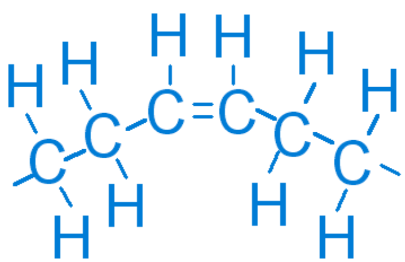


CIS

The Nature of Biology

Lipids.

- Lipids are insoluble in water
  - Transport through blood requires transport molecules (lipoproteins)
  - Low-density lipoproteins (LDLs) or ‘bad cholesterol’
    - carry cholesterol from liver to body cells
  - High-density lipoproteins (HDLs) or ‘good cholesterol’
    - collects cholesterol from the body’s tissues & brings it back to liver

The Nature of Biology

Proteins

- Protein functions:
  - Enzymes
  - Hormones
  - Antibodies
  - Structural elements in membranes and muscle
  - Storage materials (*egg yolk*)

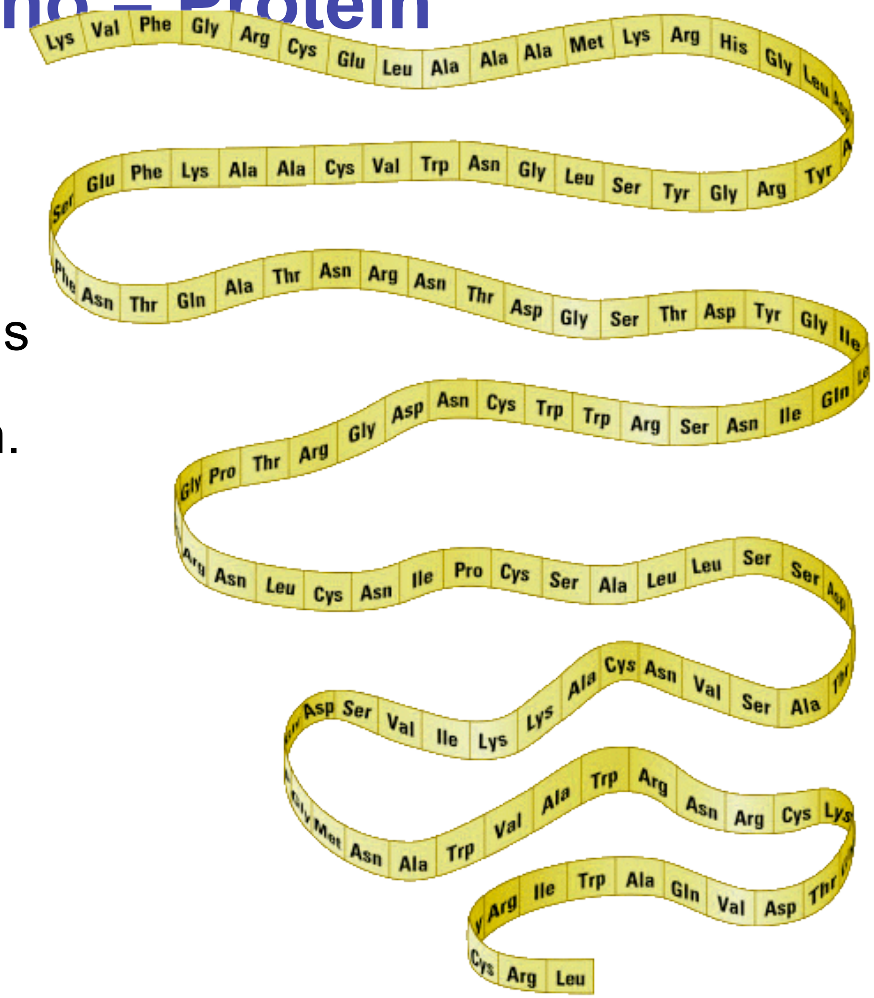
The Nature of Biology

Proteins

- Protein characteristics:
  - A protein is a polymer constructed from a common set of 20 amino acid monomers.
  - Proteins perform most of the tasks the body needs to function.
  - They are the most elaborate of life's molecules.

The Nature of Biology

Amino + Amino = Protein



- Cells link amino acids together to form proteins.
- The arrangement of amino acids makes <u>each protein different</u> & <u>unique</u> in structure and function.
- A slight change in the primary structure of a protein affects its ability to function.

The Nature of Biology

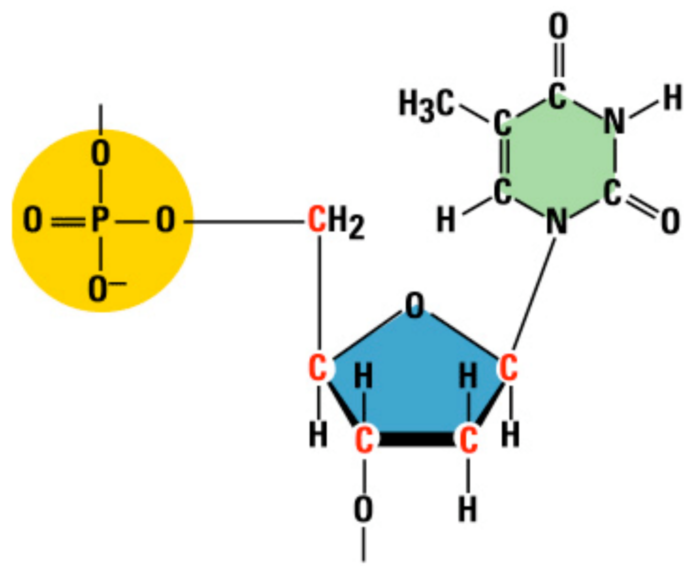
Nucleic Acids

- Nucleic acids are information storage molecules.
- They provide the directions for building proteins.
- There are two types of nucleic acids:
  - DNA, deoxyribonucleic acid
  - RNA, ribonucleic acid

The Nature of Biology

Nucleic acids are polymers of nucleotides

- Nucleotide = Phosphate + 5-Carbon sugar + Base



The Nature of Biology

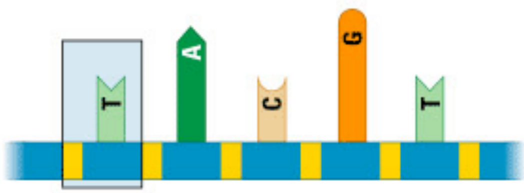
Nucleic acids are polymers of nucleotides

- Each DNA nucleotide has one of the following bases:

  - Adenine (A)
  - Guanine (G)
  - Thymine (T)
  - Cytosine (C)

The Nature of Biology

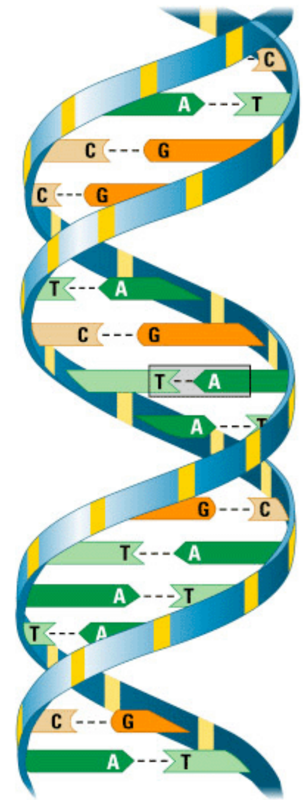
Nucleotide monomers are linked into long chains



- These chains are called polynucleotides, or DNA strands.

- A sugar-phosphate backbone joins them together.

- Two strands of DNA join together to form a double helix.



The Nature of Biology

RNA, ribonucleic acid, is different from DNA

- It has the base uracil (U) instead of thymine (T)

  - Adenine (A)
  - Guanine (G)
  - Uracil (U)
  - Cytosine (C)