THE CHEMISTRY OF LIFE!!

ATOMS, MOLECULES, AND ELEMENTS IN OUR BODY

THE HUMAN BODY

- **Water**: 62%
- **Protein**: 16%

**Elemental Composition**
- **Oxygen**: 65%
- **Carbon**: 18%
- **Hydrogen**: 9.5%
- **Nitrogen**: 3.2%
- **Calcium**: 1.5%
- **Phosphorus**: 1.2%
- **Potassium**: 0.4%
- **Sulfur**: 0.2%
- **Sodium**: 0.2%
- **Chlorine**: 0.2%
- **Magnesium**: 0.1%
- **Other >1%**

**Other Components**
- **Fat** 16%
- **Carbohydrate** 1%
- **Minerals** 6%
THE CHEMICAL LEVEL

Atoms are the smallest stable units of matter.

They can combine to form molecules with complex shapes.

The atomic components and unique three-dimensional shape of a particular molecule determine its function.

For example, complex protein molecules form filaments that produce the contractions of muscle cells in the heart.
WHY STUDY CHEMISTRY IN A CLASS ABOUT THE HUMAN BODY?

Body functions depend on cellular functions

Cellular functions result from chemical changes

Elements are made of chemically identical atoms.

Matter is anything that has mass and takes up space. It is composed of elements.

- **Bulk elements** – required by the body in large amounts
- **Trace elements** - required by the body in small amounts
- **Ultra-trace elements** – required by the body in very minute amounts
What is an **Atom**?

- **An atom** is the smallest particle that an element can be divided and still be that element.

- For example, the smallest particle of carbon is a single atom of carbon. If you divide it, it is no longer carbon anymore.

- They can combine to form molecules with complex shapes.

- The atomic components and unique three-dimensional shape of a particular molecule determine its function.
**Atoms** - composed of subatomic particles:

- **Proton** – carries a single **positive** charge
- **Neutron** – carries **no electrical charge**
- **Electron** – carries a single **negative** charge

**The Nucleus**
- Central part of atom
- Composed of **protons and neutrons**
- Electrons move **around the nucleus**
The nucleus of the atom

- The neutrons and protons are grouped together in the nucleus, which is at the center of the atom and make up most of the atom’s mass.

- There is a huge amount of space between the outer moving electrons and the nucleus.

- The electron cloud has a radius 10,000 times greater than the nucleus.

- If the atom were the size of our classroom, the nucleus would be the size of a single grain of sand in the center of the room.

- If the nucleus were the size of a peanut, the atom would be about the size of a baseball stadium.

- The diameter of the nucleus is about 1/10,000 the size of an atom but it contains more than 90% of it’s mass !!
IONS

• If an atom gains or loses one or more electrons, it acquires a net electric charge and becomes an ion.

• Hydrogen atoms and most mineral and trace element atoms readily form ions.

• Because of their charge, ions are able to conduct electricity when dissolved in water.

• The ionic forms of mineral elements are collectively referred to as electrolytes.

• It’s interesting that these are the ions we need in our body, to reduce leg and other types of cramping!!
ELECTROLYTES

❖ The proper concentration of electrolytes in your blood is essential to your health.

❖ Your cardiovascular and nervous systems, to name just two, require electrolytes to function well.

❖ Differences in the concentration of sodium and potassium inside and outside of cells allow your nerve and muscle fibers to send electrical impulses (which is how these cells communicate and get your body to react and move).

❖ When you exercise or get hot and sweat, the sweat contains salts which are electrolytes and need to be replaced.

10 FOODS TO NATURALLY REPLENISH YOUR LOST ELECTROLYTES

- Avocados
- Spinach
- Butternut Squash
- Beet Greens
- Wild-Caught Salmon
- Bananas
- Coconut Water
- Swiss Chard
- Beets
- Raisins (in moderation)
SPORTS DRINKS WITH ELECTROLYTES
IONIC BONDING

When we use salt in some of the foods we eat, the 2 atoms separate out in the watery conditions in our bodies and the cells in the stomach lining uses the chlorine atoms to make hydrochloric acid which it uses to digest our food!!

SODIUM + CHLORINE = SODIUM CHLORIDE (SALT)

Figure 2-2. Formation of an ionic bond. An atom of sodium loses an electron to an atom of chlorine. The two ions formed have unlike charges, are attracted to one another, and form a molecule of sodium chloride.
**Sodium** is a highly reactive metal, especially when put in water.

**Chlorine** is a poisonous gas but when they are made into compounds and put into a water solution, the ions of the 2, highly different materials come together to make common table salt – Sodium Chloride or NaCl.
An ionic compound: NaCl

Ionic substances tend to form crystalline shapes rather than distinct molecules.
A second type of chemical bonding is covalent bonds, which is when 2 atoms share an electron. This is how the amazing process of 2 gases – 1 atom of Hydrogen and 2 atoms of Oxygen combine together, to make water!!

\[
\text{OXYGEN} + 2 \text{ HYDROGEN ATOMS} = \text{WATER}
\]

Figure 2–3. Formation of covalent bonds. (A) Two atoms of oxygen share two electrons each, forming a molecule of oxygen gas. (B) An atom of oxygen shares one electron with each of two hydrogen atoms, each sharing its electron. A molecule of water is formed.
Honey, this old world is made up of protons, neutrons, electrons and a great big heapin' of morons!
<table>
<thead>
<tr>
<th>Organ</th>
<th>Water Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td>75% Water</td>
</tr>
<tr>
<td>Blood</td>
<td>83% Water</td>
</tr>
<tr>
<td>Heart</td>
<td>79% Water</td>
</tr>
<tr>
<td>Bones</td>
<td>22% Water</td>
</tr>
<tr>
<td>Muscles</td>
<td>75% Water</td>
</tr>
<tr>
<td>Liver</td>
<td>86% Water</td>
</tr>
<tr>
<td>Kidneys</td>
<td>83% Water</td>
</tr>
</tbody>
</table>
HUMANS ARE 72 % WATER !!

An adult who weighs 210 pounds, contains about 60 liters of water.

This is equal to 30, two-liter pop bottles of water, as shown below !!
PURE WATER

Really really pure water, the kind that is necessary to clean electronic chips used in devices like computers and smart phones is harmful to the human body.

Known as *Ultra Pure Water*, it is just normal water that has been through such a severe *cleaning* process, that only the H2O molecules are left - That means that there are no specks of dirt, salts, minerals or even viruses present in the water.

*While great for semiconductors, this is exactly the property that makes it harmful for humans. If ingested, it gets right to work and starts to absorb all the valuable minerals present in the body.*

Tests have shown that even as little as a glass of this liquid, could have a negative effect on the human body.

https://www.youtube.com/watch?v=3vKpF1D0E_U
SOLIDS, LIQUIDS, GASES, AND PLASMAS

States of Matter

SOLID   LIQUID   GAS   PLASMA

ADD HEAT

WHAT IS THEIR DIFFERENT STRUCTURE BASED ON?
The Four States of Matter

Basis of Classification of the Four types:

Based upon particle arrangement
Based upon energy of particles
Based upon distance between particles

SOLIDS                        LIQUIDS                  GASES                   PLASMAS
Phase Differences

**Solid** – definite volume and shape; particles packed in fixed positions.

**Liquid** – definite volume but indefinite shape; particles close together but not in fixed positions

**Gas** – neither definite volume nor definite shape; particles are at great distances from one another

**Plasma** – high temperature, ionized phase of matter as found on the sun and in lightning.
SOLIDS

- Coal, sugar, ice, bone, and iron.
- Definite shape and volume.
- The shape doesn’t depend on the shape of their container.
- The particles are packed tightly together and they are almost incompressible.
- Solids expand only a little, when heated.
PARTICLES OF LIQUIDS ARE TIGHTLY PACKED, BUT ARE FAR ENOUGH APART TO SLIDE OVER ONE ANOTHER.

LIQUIDS HAVE AN INDEFINITE SHAPE AND A DEFINITE VOLUME.

THEY ARE NOT COMPRESSIBLE

THEY WILL FILL THE SHAPE OF THE CONTAINER THEY ARE PUT IN.
pH OF LIQUIDS (pH stands for the potential of Hydrogen)

Definition: A number value that expresses the acidity or alkalinity of a solution on which 7 is neutral, lower values are more acid and higher values more alkaline.

Normal rain has a pH of 5.6 – slightly acidic because of the carbon dioxide picked up in the earth's atmosphere by the rain.

It is interesting to note that the pH range of seawater is normally 7.4 - 8.2, while in blood it's 7.35 - 7.45 (the body keeps this in a very tight range).
Blood pH

- Normal blood pH is 7.35 – 7.45
- **Alkalosis** occurs when blood pH rises to 7.5 – 7.8
- **Acidosis** occurs when blood pH drops to 7.0 – 7.3
- Homeostatic mechanisms help regulate pH
- Buffers are chemicals which act to resist pH changes

<table>
<thead>
<tr>
<th>pH Scale: What is Acidic, What is Alkaline?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average pH value of seawater in 2100</strong></td>
</tr>
<tr>
<td><strong>7.76</strong></td>
</tr>
<tr>
<td><strong>Average pH value of seawater in 1870</strong></td>
</tr>
<tr>
<td><strong>8.18</strong></td>
</tr>
</tbody>
</table>

![Diagram showing pH scale and examples of acidic and alkaline substances.]

The difference may seem small, but the decline in the pH value from 1870 to 2100 would mean a 170 percent increase in acidity. Much smaller changes already pose problems for many sea creatures.
pH below 7.35

SYMPTOMS OF ACIDOSIS

Central Nervous System
- Headache
- Sleepiness
- Confusion
- Loss of consciousness
- Coma

Respiratory System
- Shortness of breath
- Coughing

Heart
- Arrhythmia
- Increased heart rate

Muscular System
- Seizures
- Weakness

Digestive System
- Nausea
- Vomiting
- Diarrhea

pH above 7.45

SYMPTOMS OF ALKALOSIS

Central Nervous System
- Confusion
- Light-headedness
- Stupor
- Coma

Peripheral Nervous System
- Hand tremor
- Numbness or tingling in the face, hands, or feet

Muscular System
- Twitching
- Prolonged spasms

Digestive System
- Nausea
- Vomiting
GASES

- They take the shape and form of their container (flowable).
- Particles are spaced far apart.
- Gases expand without limit to fill any space.
- Gases are easily compressed.
GAS AS STEAM VAPOR

- The gaseous state of a substance that is generally a liquid or solid at room temperature.
- Steam is referred to as a vapor because water is a liquid at room temperature.
- Moist air contains water vapor.
- **Evaporation** of water occurs when the surface of the liquid is exposed, allowing molecules to escape and form water vapor; this vapor can then rise up and form clouds.
NITRIC OXIDE GAS

You have probably heard of it as a component of air pollution and cigarette smoke.

It is also synthesized by several human tissues, and this deceptively simple molecule has important functions, as shown on the picture.

Studies also show that nitric oxide helps some premature babies breathe more easily and efficiently.
PLASMA

Plasma is by far the most common form of matter.

It is in all the stars and in the tenuous space between them, which makes up over 99% of the visible universe and perhaps most of that which is not visible.

Plasma temperatures and densities range from relatively cool and tenuous (like aurora) to very hot and dense (like the central core of a star).

It is defined as an ionized (electrically charged) gas and has no defined shape or volume.
ELEMENTS - All matter, both living and not living, is made of elements, the simplest chemicals.

➢ An element is a substance made of only one type of atom (therefore, an atom is the smallest part of an element).

➢ 25 of the 92 naturally occurring elements are essential to life.

➢ The 5 elements carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur are found in all living things.

➢ IF CALCIUM IS INCLUDED, THESE SEVEN ELEMENTS MAKE UP APPROXIMATELY 99% OF THE HUMAN BODY ( BY WEIGHT).

<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Percentage of Body Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Elements (Total 98.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>65.0</td>
</tr>
<tr>
<td>Carbon</td>
<td>C</td>
<td>18.0</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>10.0</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>3.0</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>1.5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>1.0</td>
</tr>
<tr>
<td>Lesser Elements (Total 0.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>S</td>
<td>0.25</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>0.20</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na</td>
<td>0.15</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>0.15</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>0.05</td>
</tr>
<tr>
<td>Iron</td>
<td>Fe</td>
<td>0.006</td>
</tr>
<tr>
<td>Trace Elements (Total 0.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>Cr</td>
<td>Molybdenum</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Co</td>
<td>Selenium</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu</td>
<td>Silicon</td>
</tr>
<tr>
<td>Fluorine</td>
<td>F</td>
<td>Tin</td>
</tr>
<tr>
<td>Iodine</td>
<td>I</td>
<td>Vanadium</td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn</td>
<td>Zinc</td>
</tr>
</tbody>
</table>
A human body is made of 25 chemical elements and all of them except hydrogen were created in the super-hot, high-pressure interior of stars violently coming to the end of their lives.

Hydrogen gas was created when the “Big Bang” happened that created the Universe.
“Every atom in your body came from a star that exploded. And, the atoms in your left hand probably came from a different star than your right hand.

It really is the most poetic thing I know about physics: You are all stardust.

—Lawrence M. Krauss
Carbon is a key component of all known life on Earth, representing approximately 45-50% of all living things, such as animals and plants.

Complex molecules are made up of carbon bonded with other elements, especially oxygen and hydrogen and frequently also with nitrogen, phosphorus and sulfur.

It is also lightweight and relatively small in size, making it easier for enzymes to manipulate carbon molecules.

It is frequently assumed in astrobiology that if life exists elsewhere in the universe, it will also be carbon-based.

In a 2018 study carbon was found to compose approximately 550 billion tons of all life on Earth.
How are Elements Classified?

**Four Regions:** metals, nonmetals, metalloids, & inert gases. 75% or more of all of the elements are metals !!!

https://www.ptable.com/

https://www.youtube.com/watch?v=ZGMwSKFBpo
THE ESSENTIAL BODY ELEMENTS IN THE PERIODIC TABLE.

The 19 elements that are known to be essential for human life are shown in purple.

The 7 elements that are also suggested to be essential are shown in green.

<table>
<thead>
<tr>
<th>Essential for humans</th>
<th>Suggested to be essential for humans</th>
<th>Nonessential for humans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Li</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Be</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Na</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mg</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ca</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sc</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ti</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cr</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Co</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ni</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cu</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ga</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ge</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>As</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Se</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Br</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kr</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rb</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sr</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Y</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zr</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nb</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mo</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tc</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ru</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rh</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pd</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ag</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cd</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>In</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sn</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sb</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Te</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Xe</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
25 Elements Essential for Life

- 96% of living matter made of 4 elements:
  - Oxygen (O)
  - Carbon (C)
  - Hydrogen (H)
  - Nitrogen (N)
- Most of remaining 4% just 7 elements
- Remaining >0.1% are “Trace Elements”

**Calcium (Ca): 1.5%**
**Phosphorus (P): 1.0%**
**Potassium (K): 0.4%**
**Sulfur (S): 0.3%**
**Sodium (Na): 0.2%**
**Chlorine (Cl): 0.2%**
**Magnesium (Mg): 0.1%**

**Trace elements: less than 0.01%**
- Boron (B)
- Chromium (Cr)
- Cobalt (Co)
- Copper (Cu)
- Fluorine (F)
- Iodine (I)
- Iron (Fe)
- Manganese (Mn)
- Molybdenum (Mo)
- Selenium (Se)
- Silicon (Si)
- Tin (Sn)
- Vanadium (V)
- Zinc (Zn)
TRACE ELEMENTS

**Trace elements** are those that are needed by the body in very small amounts.

When they are present in food or nutritional supplements, we often call them minerals.

Although they may not be as abundant in the body as are carbon, hydrogen, or oxygen, they are still essential.
Nutrition is the utilization of ingested substances by a healthy individual for life.

- Food can be divided into six groups:
  - carbohydrates
  - lipids
  - proteins
  - vitamins
  - minerals
  - water
Trace minerals have vital roles in the body.

**Trace Mineral Functions in the Body**

- Hardens tooth enamel
  - Fluoride

- Component of thyroid hormones
  - Iodine

- Bone health
  - Copper
  - Manganese

- Growth & wound healing
  - Zinc
  - Manganese

- Antioxidant activity
  - Selenium
  - Zinc
  - Copper
  - Manganese

- Required for enzyme function
  - Copper
  - Iron
  - Zinc
  - Molybdenum
  - Manganese
  - Selenium

- May enhance insulin function
  - Chromium
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Health Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>Manages diabetes and boosts brain function</td>
</tr>
<tr>
<td>Iron</td>
<td>Aids in formation of hemoglobin and prevents anemia</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Treats high blood pressure, lowers anxiety and stress</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>Reduces muscle weakness and corrects sexual weakness</td>
</tr>
<tr>
<td>Zinc</td>
<td>Manages skin care, eczema, acne, heals wound and night blindness</td>
</tr>
<tr>
<td>Calcium</td>
<td>Boosts bone health, relieves insomnia and improves dental health</td>
</tr>
</tbody>
</table>
13 PLANT FOODS HIGH IN IRON

Spinach, Lentils, Kidney beans, Potatoes, Oats, Soybeans, Quinoa, Almonds, Swiss chard, Peas, Chickpeas

13 ZINC RICH FOODS

Cereals, Wheat germ, Sesame seeds, Pumpkin Seeds, Meats, Shellfish, Squash Seeds, Fruits, Vegetables, Spinach, Mushroom, Dark Chocolate, Nuts

Thirteen naturally rich sources of plant-based iron.

www.TheVeganJunction.com
<table>
<thead>
<tr>
<th>Food Sources of Copper (Cu)</th>
<th>Food Sources of Manganese (Mn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>kale</td>
<td>tea</td>
</tr>
<tr>
<td>whole grains</td>
<td>spinach</td>
</tr>
<tr>
<td>cashew</td>
<td>bread</td>
</tr>
<tr>
<td>prunes</td>
<td>wheat germ</td>
</tr>
<tr>
<td>mushrooms</td>
<td>coffee</td>
</tr>
<tr>
<td>tempeh</td>
<td>pumpkin seeds</td>
</tr>
<tr>
<td>goat cheese</td>
<td>bass</td>
</tr>
<tr>
<td>oysters</td>
<td>hazelnuts</td>
</tr>
<tr>
<td>liver</td>
<td>mussels</td>
</tr>
<tr>
<td>sesame seeds</td>
<td>chocolate</td>
</tr>
<tr>
<td>avocados</td>
<td>lima beans</td>
</tr>
<tr>
<td>chickpeas</td>
<td>tofu</td>
</tr>
</tbody>
</table>
Foods Rich in Iodine

DRIED SEAWEED  COD FISH  YOGURT

BAKED POTATO  EGGS  TUNA

TURKEY  CRANBERRIES  STRAWBERRIES

Foods with selenium

Brazii nuts  tuna  beef

brown rice  eggs  whole wheat bread

chicken  cottage cheese  baked beans

oatmeal
CHROMIUM RICH FOODS
- Romaine Lettuce
- Broccoli
- Tomatoes
- Black Pepper
- Oats
- Barley

FLUORIDE RICH FOODS
- Banana
- Avocado
- Strawberries
- Plums
- Grapefruit
- Cherries
- Pears
- Cantaloupe
- Apple
There are 13 essential vitamins (A, B, C, D, E, and K, with 8 vitamins in the B complex) and many minerals the body requires for optimal health.

Although they are all considered micronutrients, **vitamins and minerals differ in basic ways.**

**Vitamins are organic and can be broken down by heat, air, or acid.**

**Minerals are inorganic and hold on to their chemical structure.**

If you eat a balanced, healthy diet, you are probably already getting adequate amounts of the essential nutrients your body needs to function at its best level.

They cannot be synthesized in sufficient quantities by an organism and must be obtained from our diet or with supplements.
Health Benefits of Vitamins

- **Vitamin A**: Beneficial in treating eye disorders, skin infections
- **Vitamin B9**: Reduces risk of neural tube defects during pregnancy
- **Vitamin B12**: Provides relief from symptoms of anemia, kidney and liver disorders
- **Vitamin C**: Helps treat scurvy, cancer and common cold
- **Vitamin D**: Aids in treating arthritis, tooth decay, diabetes and rickets
- **Vitamin E**: Improves blood circulation and slows down aging process
- **Vitamin K**: Reduces risk of menstrual pain and internal bleeding
Lipids are materials in the body that are made of compounds that are fats, oils, or waxes.

**USES:**

- Long-term energy storage
- Insulation
- Provide a waterproof covering
- Part of biological membranes
- Chemical messengers (steroids)
- They contain mostly carbon and hydrogen
- Generally not soluble in water
There are 2 types of Vitamins – those that are Lipid Soluble and those that are Water Soluble:

1) LIPID (FAT)-SOLUBLE VITAMINS ARE A, D, E AND K

The vitamins are not dissolved in water but are absorbed efficiently with lipids.

2) WATER-SOLUBLE VITAMINS ARE THE 8 B VITAMINS AND VITAMIN C

Function: mainly to maintain body enzymes

They are not readily stored in the body and after use, are excreted from the body

Their consistent daily intake is important.
INFORMATION ABOUT THE LIPID (FAT) SOLUBLE VITAMINS – A, D, E, AND K
Health Benefits of Vitamin A

- Prevents cancer
- Builds immune system
- Supports bodily functions
- Delays signs of ageing
- Improvement in vision
- Makes the bones stronger
- Prevents urinary stones
- Promotes muscle growth
- Reduces acne
- Antioxidant capabilities

Sources of Vitamin A

- Carrots
- Papaya
- Meat
- Eggs & Cheese
- Squash
- Fish
- Mangoes
- Peppers
- Broccoli
- Apricots
- Peaches
- Melon
- Avocado
**Vitamin D properties** - Its main function is absorption of calcium and phosphorus from food in the small intestine.

It is also believed to take part in the regulation of cell growth, metabolism and stimulation of some hormones synthesis and is very important for our immunity system.

**You can also get it by doing at least 10 minutes of sunbathing a day!**

**Vitamin D sources:**

- Cod liver oil
- Mushrooms
- Oily fish
- Caviar
- Cereals
- Tofu
- Dairy
- Pork
- Eggs
- Soy yogurt.

**VITAMIN D Sources**

*lovandy.com*
Vitamin E is a group of natural compounds and is mostly tocopherol.

It has a huge role in metabolism, helping your circulatory system, liver and stomach work properly and is good for your skin.

**Food sources of Vitamin E:**

Spinach  
Nuts  
Sunflower seeds  
Avocados  
Shellfish  
Trout  
Olives  
Broccoli  
Squash and pumpkin
Vitamin K

Its real name is Phylloquinone. This vitamin helps in bones metabolism and kidney’s work; takes part in calcium absorption.

In addition, this nutrient provides better interaction of calcium and vitamin D.

**Sources of Phylloquinone:**

- Herbs
- Kale
- Onions
- Brussels sprouts
- Chili powder
- Asparagus
- Pickles
- Soybeans
- Olive oil
WATER SOLUBLE VITAMINS

- Vitamin B₁ (thiamine)
- Vitamin B₂ (riboflavin)
- Vitamin B₃ or Vitamin P or Vitamin PP (niacin)
- Vitamin B₅ (panthotenic acid)
- Vitamin B₆ (pyridoxine and pyridoxamine)
- Vitamin B₇ or Vitamin H (biotin)
- Vitamin B₉ or Vitamin M and Vitamin B-c (folic acid)
- Vitamin B₁₂ (cobalamin)
Vitamin B1 – It is also known as Thiamin.

It is one of the most important nutrients for metabolism of fats, proteins and carbohydrates.

It helps your body normalize growth processes and maintain proper functioning of the heart, nervous and digestive systems.

**Sources of B1 vitamin:**

- Fish
- Pork
- Seeds of sunflower
- Nuts (Macadamia)
- Wheat bread
- Green peas
- Squash
- Asparagus
- Dry roasted soy beans
- Other beans
Vitamin B2

It is known as riboflavin, one of the most important water-soluble vitamins.

Vitamin B2 is needed to form red blood cells and antibodies. In addition, it regulates some growth and reproductive functions and helps with skin, nails and hair health.

Sources of B2:

Cheese
Almonds
Beef and lamb
Oily fish
Eggs
Pork
Mushrooms
Sesame seeds
Seafood
**Vitamin B5** - Its scientific name is Pantothenic acid.

This name in Greek means ‘everywhere’, as this nutrient is extremely widespread.

It helps with metabolism of fats, carbohydrates and amino acids and helps to maintain mucous membranes.

**Where can you find it?**

- Mushrooms
- Cheese
- Fish
- Avocados
- Eggs
- Lean pork
- Beef and Veal
- Chicken or turkey

---

**VITAMIN B5**

Sources

*lovandy.com*
Vitamin B6

B6 vitamin is a common name for nutrients that have a biological activity of pyridoxine.

Your body uses it in synthesis of serotonin, dopamine, epinephrine and norepinephrine.

It is also used in treatment of a large quantity of epidermis (skin) diseases.

**Sources of B6:**

- Sunflower seeds
- Pistachio nuts
- Tuna
- Turkey
- Pork
- Prunes
- Beef
- Bananas
- Avocados
**Vitamin B9** – also known as folic acid, is essential for growth and development of the immune and circulatory systems.

This means that B9 is needed to create new cells and keep them healthy and gives good skin protection against harmful solar radiation.

**B9 sources:**
- Beans
- Lentils
- Spinach
- Asparagus
- Lettuce
- Avocado
- Broccoli
- Mangos
- Oranges
- Wheat bread
Vitamin B12

Its second name is Cyanocobalamin.

This nutrient provides different types of enzymatic reactions. This means, your body needs it for proper metabolism and for good food digestion.

It is also important for cell regeneration.

Natural sources of B12:

• Shellfish
• Liver
• Fish
• Crustaceans
• Tofu
• Bran;
• Red meat
• Dairy
• Cheese
VITAMIN B12

**B12 rich foods**
- Fish
- Oyster and Crab
- Poultry
- Milk
- Eggs
- Meat
- Cheese
- Nuts

**B12 benefits**
- Prevent Breast Cancer
- Alzheimer's Disease Treatment
- Against Body Fatigue and Weakness
- Prevents Anemia and helps formation of DNA
- Useful in Treating Sickle Cell Anemia
- Maintains Proper Functioning of Heart
- Helps to Maintain Strong Nervous System
- Helps in Formation and Maintenance of Red Blood Cells
VITAMIN C

- Cure for the common cold
- Protection against immune system deficiencies
- Prevents cardiovascular disease
- Maintains healthy skin & wrinkling
- Important for eye health
- Prevents cancer and stroke
- Essential for the body to make collagen

Top 12 Vitamin C Foods

1. Rosehip
2. Strawberries
3. Guava
4. Bell Peppers
5. Parsley
6. Papaya
7. Broccoli
8. Citrus Fruits
9. Kale
10. Brussel Sprouts
11. Pineapple
12. Kiwi
Vitamin P

This vitamin (known as the group of flavonoids) helps to reduce permeability and fragility of blood capillaries.

With a proper level of P vitamin in your body, the concentration of hyaluronic acid increases, which leads to increasing of capillaries’ elasticity.

Furthermore, it has antioxidant properties and protects against oxidation of ascorbic acid.

Where to find flavonoids?

Seeds
Cheese
Salmon
Shellfish
Nuts
Pork
Beef
Dairy
Tofu
Vitamin H

**Its original name is biotin.** This nutrient helps in metabolism of fatty acids and generates glucose.

In addition, biotin participates in production of enzymes.

**Sources of Vitamin H:**

Liver  
Chicken  
Seafood  
Milk  
Eggs  
Cheese  
Yeast  
Tuna and salmon  
Berries
THE VITAMINS

Vitamin A has a mission
To give to you strong bones and vision

Vitamin D is from the sun
And helps the mineral calcium

Vitamin E always goes zoom
To help your system stay immune

Vitamin K helps you clot
That way you won't bleed a lot

Vitamin C won't let you get sick
You'll pump iron more quick... ly

B Vitamins one, two, three; five, six, seven
Work to keep your engine revvin'

Folic acid is number nine
Keeps your DNA working fine

Twelve is needed you will see
For nerves and blood and energy
There are two kinds of chemicals that make up the human body: **inorganic** and **organic** chemicals.

Although there are some exceptions, **inorganic** chemicals are primarily molecules that are made up of one or two elements that are not carbon.

**Water** (H\(_2\)O) and **oxygen** (O\(_2\)) are examples of inorganic chemicals that are important for the human body to function, as are **iron** (Fe), **calcium** (Ca), and **sodium** (Na).

One exception is **carbon dioxide** (CO\(_2\))—even though this contains a gas that the body can’t use and must be expelled from the lungs.
Classes of Organic Molecules

- **Carbohydrates (sugars)**
  - Monosaccharides
  - Disaccharide
  - Polysaccharides

- **Lipids**
  - *Fatty Acids*
  - *Triglycerides*
  - *Phospholipids*
  - *Steroids*

- **Proteins**
  - *Amino Acid Subunits*
  - *Polypeptides*

- **Nucleic Acids**
  - *Deoxyribonucleic acid (DNA)*
  - *Ribonucleic acid (RNA)*
Carbohydrates (sugars)

- They are the main source of energy for organisms

- Made of Carbon, Hydrogen, and Oxygen

- The monomers of carbohydrates are called monosaccharides, like glucose, fructose (in fruits) and galactose (in milk).

- The breakdown of monosaccharides supplies immediate energy.

- They usually end in \(-ose,\) such as Glucose, Sucrose, etc.

- Extra sugar is stored as macro-molecules (groups of molecules) called polysaccharides.

- Polysaccharides are made from monosaccharides.
## SOURCES OF SMART CARBOHYDRATES

For a full list of foods visit: [www.sleekgeek.co.za/foodlist](http://www.sleekgeek.co.za/foodlist)

<table>
<thead>
<tr>
<th>STARCHY VEG</th>
<th>WHOLE GRAIN</th>
<th>FRUIT (Fresh, not dried)</th>
<th>FRUIT (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butternut Squash</td>
<td>Amaranth</td>
<td>Apples</td>
<td>Mangoes</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Barley</td>
<td>Apricots</td>
<td>Melons</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>Buckwheat</td>
<td>Bananas</td>
<td>Nectarines</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>Oats</td>
<td>Berries and Cherries</td>
<td>Oranges</td>
</tr>
<tr>
<td></td>
<td>Quinoa</td>
<td>Figs</td>
<td>Peaches</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>Grapefruit</td>
<td>Pears</td>
</tr>
<tr>
<td></td>
<td>Sorghum</td>
<td>Grapes</td>
<td>Persimmons</td>
</tr>
<tr>
<td></td>
<td>Spelt</td>
<td>Guavas</td>
<td>Pineapple</td>
</tr>
<tr>
<td></td>
<td>Sprouted Grains</td>
<td>Kiwifruit</td>
<td>Plums</td>
</tr>
</tbody>
</table>

(You can bump up your protein intake with legumes and whole grains.)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Lemons and Limes</th>
<th>Pomegranates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legumes</td>
<td>Beans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chickpeas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lentils</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peas and Pulses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                |                      |                          | Watermelon                  |
USES OF POLYSACCHARIDES - GLYCOGEN

• Many animals store extra sugar as glycogen.

• Glycogen stored in your liver is released when glucose in your blood runs low.

• Glycogen stored in your muscle supplies energy for muscle contractions.
AMINO ACIDS ARE SIMPLE ORGANIC COMPOUNDS THAT COMBINE TO FORM PROTEINS

- Proteins consist of long chains of organic molecules called amino acids and make up each body cell.
- Each gene encodes a single protein, although some complex proteins are encoded by more than one gene.
- Proteins have a wide range of vital functions in the body.
  - They form structures such as skin or hair
  - Carry signals around the body
  - Fight off infectious agents such as bacteria.
  - Perform the thousands of basic biochemical processes needed to sustain life.
The body is made up of 20% Protein!!

Proteins are large, complex molecules that play many critical roles in the body. They do most of the work in cells and are required for the structure, function, and regulation of the body’s tissues and organs.

They are made up of hundreds or thousands of smaller units called amino acids, which are attached to one another in long chains.

There are 20 different types of amino acids that can be combined to make a protein.

The sequence of amino acids determines each protein’s unique 3-dimensional structure and its specific function.

Proteins can be described according to their large range of functions in the body, listed in alphabetical order, as shown on the next page:
## EXAMPLES OF PROTEIN FUNCTIONS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibody</td>
<td>Antibodies bind to specific foreign particles, such as viruses and bacteria, to help protect the body.</td>
<td>Immunoglobulin G (IgG)</td>
</tr>
<tr>
<td>Enzyme</td>
<td>Enzymes carry out almost all of the thousands of chemical reactions that take place in cells. They also assist with the formation of new molecules by reading the genetic information stored in DNA.</td>
<td>Phenylalanine hydroxylase</td>
</tr>
<tr>
<td>Messenger</td>
<td>Messenger proteins, such as some types of hormones, transmit signals to coordinate biological processes between different cells, tissues, and organs.</td>
<td>Growth hormone</td>
</tr>
<tr>
<td>Structural component</td>
<td>These proteins provide structure and support for cells. On a larger scale, they also allow the body to move.</td>
<td>Actin</td>
</tr>
<tr>
<td>Transport/storage</td>
<td>These proteins bind and carry atoms and small molecules within cells and throughout the body.</td>
<td>Ferritin</td>
</tr>
</tbody>
</table>
Proteins in the Human Body

Proteins in the Immune System
- Antibodies - fight invaders
- Complement System - system of 20 protein molecules that are activated during infections

Proteins in the Muscle
- Actin and Myosin - interactions with each other for muscle movement
- Myoglobin - release oxygen to muscles
- Ferritin - stores and release oxygen

Proteins in the Blood
- Hemoglobin - transports oxygen
- Fibrinogen - clots blood
- Albumin - maintain proper amount of liquid in blood

Signaling Proteins
- Cytokines - communicate with other cells

Structural Proteins
- Cytoskeleton - network of protein filaments and tubules that maintain cell shape
- Keratin - found in skin, hair, and nails
- Collagen - provides strength
- Elastin - provides flexibility

Enzymes
- Digestive Enzymes - helps break down food

Cell Membrane
- Form channels for substances to move through membrane
- Act as enzymes
- Act as receptors
- Three types of proteins: peripheral protein, integral protein, and lipid-bound protein
Proteins have four levels of organization.

- This allows for the unique shape of proteins.
- Shape is very important; if a protein is not the right shape, it will not work.
DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms.

Nearly every cell in a person’s body has the same DNA.

Most DNA is located in the cell nucleus but a small amount can also be found in the mitochondria which are structures within cells that convert the energy from food into a form that cells can use.
The information in DNA is stored as a code made up of four chemical bases:

Adenine (A)

Guanine (G)

Cytosine (C)

Thymine (T)

- Human DNA consists of about 3 billion bases, and more than 99 percent of those bases are the same in all people.

- The order, or sequence, of these bases determines the information available for building and maintaining an organism.

- The process is similar to the way in which letters of the alphabet appear in a certain order to form words and sentences.
If you stretched each strand of the **DNA** in one cell all the way out, it would be about 2 meters (over 6 feet) **long**.

Using the process of extreme coiling, this allows the 3 billion base pairs in each cell to fit into a space just 6 microns (millionths of a meter) across.

If all of the DNA in all your cells were stretched out and put together end to end, they would be about twice the diameter of the Solar System!
Nucleic Acids

• They store and transmit hereditary, or genetic, information

• They contain hydrogen, carbon, nitrogen, oxygen, and phosphorus

• Nucleic acids are very large and complex molecules.

• There are two types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

4.8 minute good video - https://www.youtube.com/watch?v=zwibqNGe4a
<table>
<thead>
<tr>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
</table>
| • Makes up the chromosomes within the cell’s nucleus  
• Holds the genetic code  
• Controls heredity  
• Determines which proteins will be synthesized in a cell and thus controls the cell’s activity | • May be present in either the nucleus or the cytoplasm and there are three types:  
- **messenger R** *(mRNA)* carries genetic information from DNA  
- **transfer RNA** *(tRNA)* is involved in amino-acid activation during protein synthesis  
- **ribosomal RNA** *(rRNA)* is involved in ribosome structure. |
The genetic similarity between a **human** and a **banana** is... **60%**

**Source:** National Human Genome Research Institute

The genetic similarity between a **human** and a **fruit fly** is... **61%**

**Source:** National Aeronautics Space Administration (NASA)

The genetic similarity between a **human** and a **cow** is... **80%**

**Source:** Science Magazine

The genetic similarity between a **human** and a **cat** is... **90%**

**Source:** Genome Research

The genetic similarity between a **human** and a **mouse** is... **85%**

**Source:** National Human Genome Research Institute

The genetic similarity between a **human** and a **chimpanzee** is... **96%**

**Source:** National Human Genome Research Institute

---

**THE END**