Topic 1: Lifestyle, Health and Risk

SPECIFICATION

- Many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).
- Importance of water as a solvent in transport, including its dipole nature.
- The structures of blood vessels (capillaries, arteries and veins) relate to their functions.
- The cardiac cycle (atrial systole, ventricular systole and cardiac diastole) and relate the structure and operation of the mammalian heart, including the major blood vessels, to its function.
- The relationship between heart structure and function can be investigated practically.
- The course of events that leads to atherosclerosis (endothelial dysfunction, inflammatory response, plaque formation, raised blood pressure).
- Blood-clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).
- Factors such as genetics, diet, age, gender, high blood pressure, smoking and inactivity increase the risk of cardiovascular disease (CVD).
- Analyse and interpret quantitative data on illness and mortality rates to determine health risks, including distinguishing between correlation and causation and recognising conflicting evidence.
- Evaluate the design of studies used to determine health risk factors, including sample selection and sample size used to collect data that is both valid and reliable.

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SPECIFICATION

- People's perceptions of risks are often different from the actual risks, including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease.
- Analyse data on energy budgets and diet.
- Consequences of energy imbalance, including weight loss, weight gain, and development of obesity.
- Difference between monosaccharides, disaccharides and polysaccharides, including glycogen and starch (amylose and amylopectin).
- Relate the structures of monosaccharides, disaccharides and polysaccharides to their roles in providing and storing energy (β-glucose and cellulose are not required in this topic).
- Monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.
- A triglyceride is synthesised by the formation of ester bonds during condensation reactions between glycerol and three fatty acids.
- Differences between saturated and unsaturated lipids.
- Analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs).

Topic 1: Lifestyle, Health and Risk

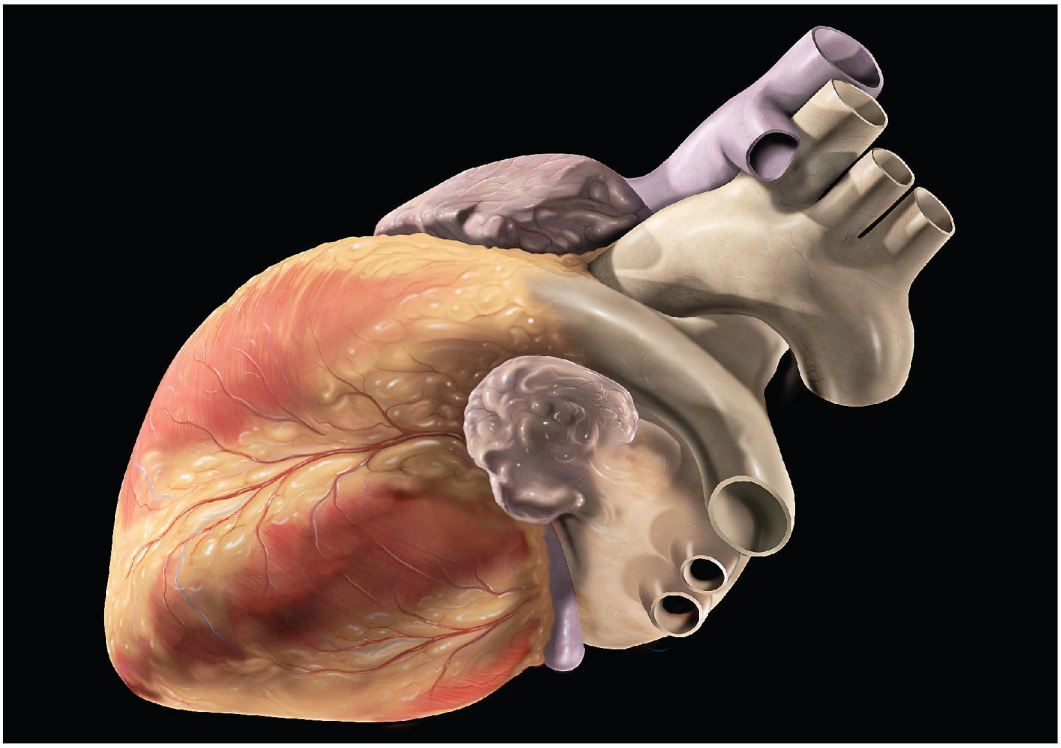
SPECIFICATION

- Evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and cardiovascular disease (CVD).
- People use scientific knowledge about the effects of diet, including obesity indicators, body mass index and waist-to-hip ratio, exercise and smoking to reduce their risk of coronary heart disease.
- The potential ethical issues regarding the use of invertebrates in research.
- Benefits and risks of treatments for cardiovascular disease (CVD) (antihypertensives, statins, anticoagulants and platelet inhibitors).

Lifestyle of an individual plays an important role in their well being. A healthy lifestyle is important for good health and sound mind. It is very important to know what to eat and what not to eat for a healthy being.

Heart and Circulatory System

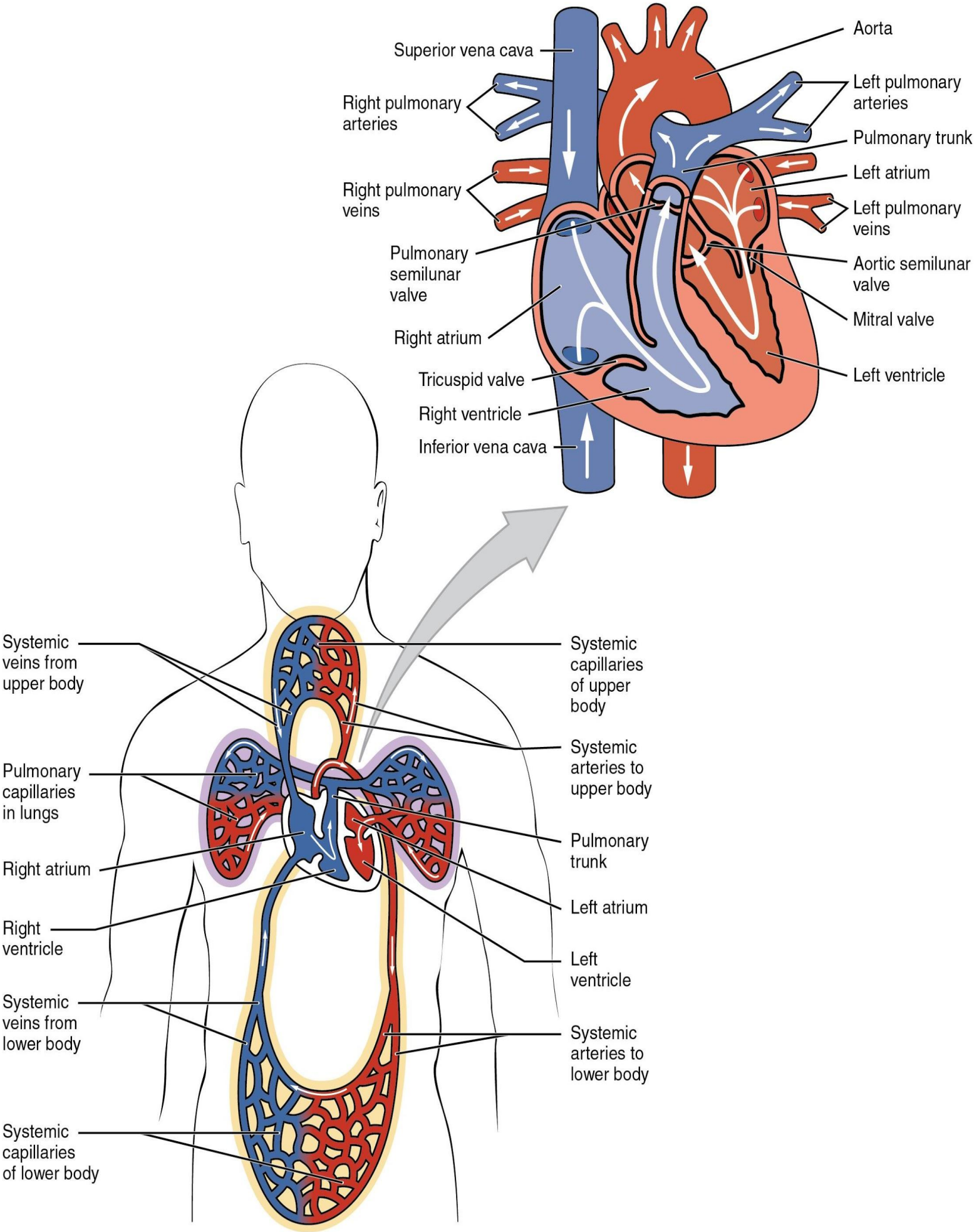
- The heart is a vital organ that acts as a muscular pump.
- It pumps blood in and out of the lungs.
- It is divided into right side and left side.
- The right side pumps deoxygenated blood into the lungs and the left side pumps oxygenated blood out of the lungs.



A Heart
Image Source: OpenStax CNX

Why Circulation is Important?

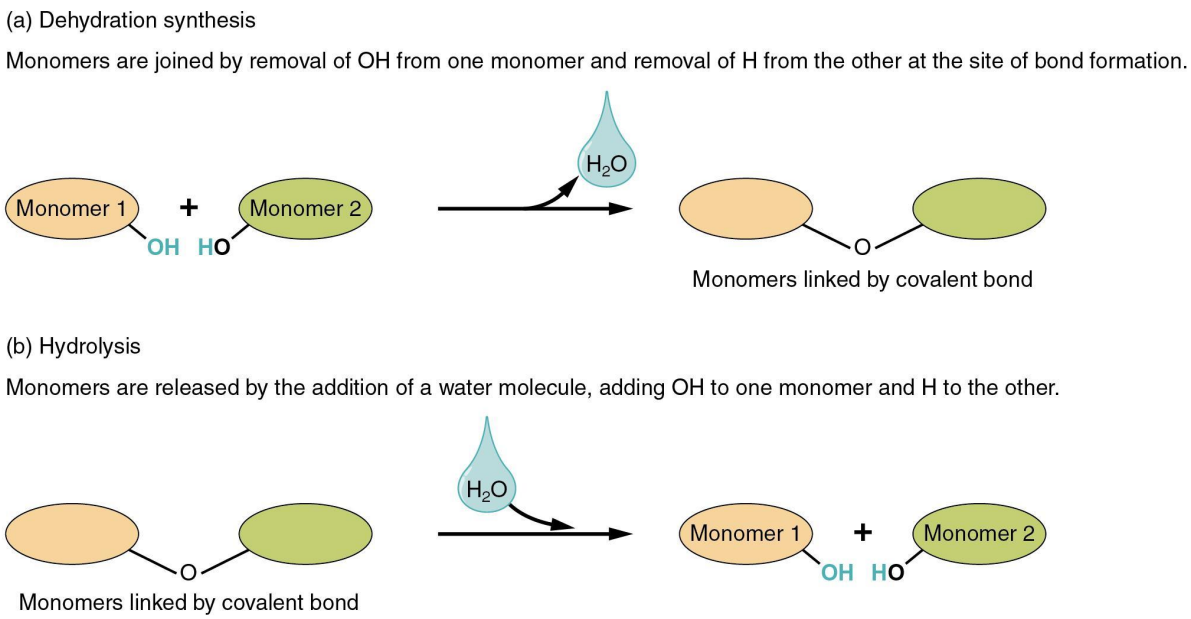
- Constant movement of any fluid is referred to as circulation. In mammals circulation of blood is very important.
- Constant movement of blood to all parts of the body is important for proper functioning of muscles and cells.
- Blood circulation provides oxygen to all body parts.
- It promotes cell growth and proper functioning of organs.
- Cells need energy (as glucose) and oxygen for proper functioning. Glucose and oxygen is provided by blood through circulation.
- Tissue, cells and organs also dispose their metabolic waste into the blood.
- If circulation is hampered or obstructed in any way, it leads to cold feet, or a cold sensation in the body part, tiredness, etc.
- Eating healthily and exercising can help blood circulation throughout the body.



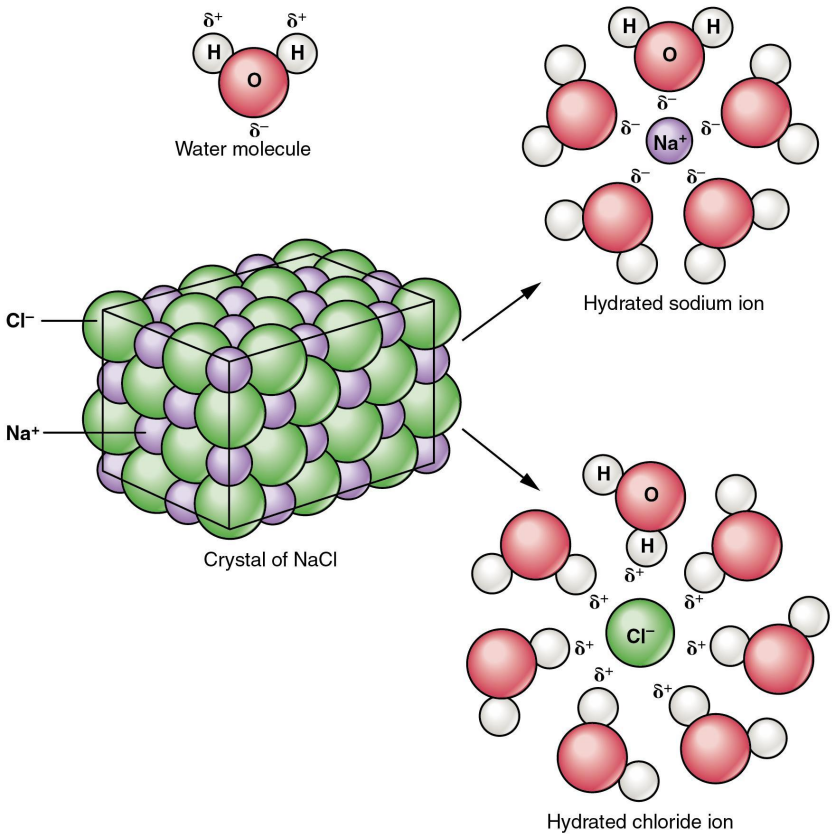
Human Blood Circulation
Image Source: OpenStax CNX

Water as a Universal Solvent

- Water is made up of hydrogen and hydroxyl ions. It is dipolar in nature thus it attracts both positively and negatively charged ions towards it.
- It is a universal and very important solvent in all living organisms.
- 70% of the human body weight is water.
- Ions can dissolve in water present in the blood and can be transported to various parts of the body.



Water as a Solvent
Image Source: OpenStax CNX



Dissociation of Salt in Water
Image Source: OpenStax CNX

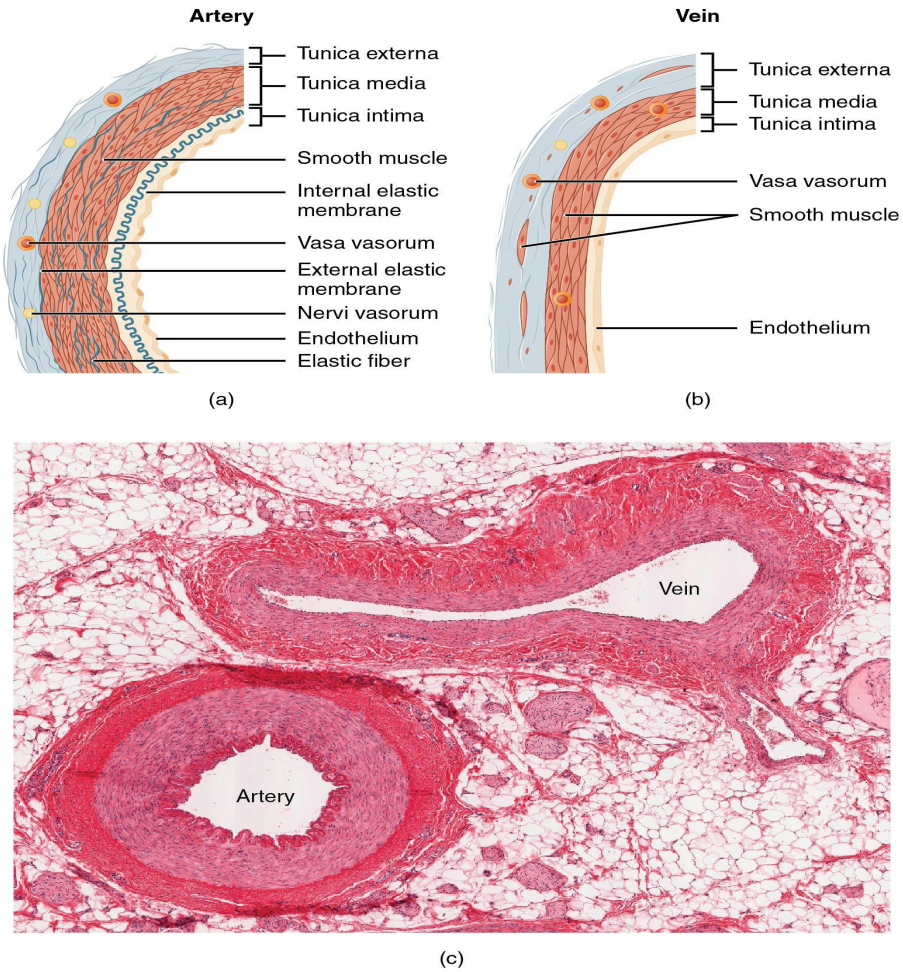
Structure of Blood Vessels

The blood vessels include:

✓ Capillaries
✓ Veins
✓ Arteries

- Blood is pumped to various body parts and organs with the help of these blood vessels.

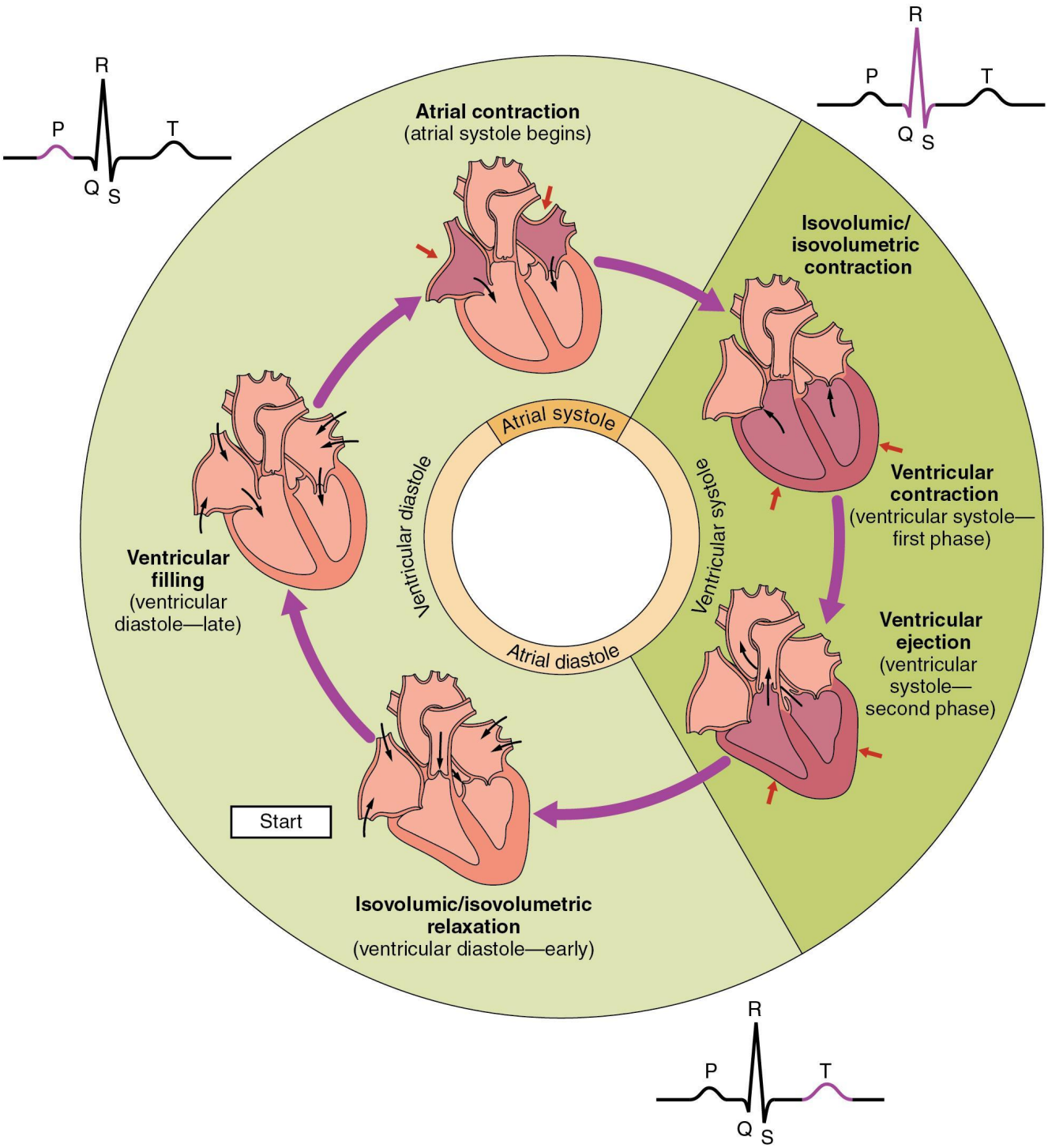
1. Arteries
   - Arteries are thick-walled blood vessels and carry blood from the heart to all body parts.
   - These are closer to heart.
   - These have smaller lumen that help to maintain blood pressure in the system.
2. Veins
   - Veins take deoxygenated blood from all parts of the body back to the heart.
   - They are not as thick-walled as arteries.
   - These have valves that prevent backflow of blood.
   - These are wider than arteries.
3. Capillaries
   - These are the smallest of all blood vessels.
   - These are fine network-like structures found in tissue.
   - These are only one cell thick.
   - These diffuse glucose and oxygen into the cells.



Artery and Vein
Image Source: OpenStax CNX

Cardiac Cycle

- **The cardiac cycle** is one complete contraction of atria and relaxation of ventricles.
- It is an ongoing process.
- The period of contraction is called systole and the period of relaxation is called diastole.
- There are three stages in a cardiac cycle.
  1. Ventricular Diastole and Atrial Systole
  2. Ventricular Systole and Atrial Diastole
  3. Cardiac Diastole



Cardiac Cycle
Image Source: OpenStax CNX

Ventricular Diastole and Atrial Systole
- At this stage, ventricles are relaxed.
- The atria contracts releasing the blood into the ventricles.
- This causes pressure in the ventricles.

Ventricular Systole and Atrial Diastole
- At this stage, the atria relax.
- The ventricles contract, release the blood into the aorta and pulmonary veins.
- The valves shut down.
- The pressure inside ventricles is greater than that in the atria.

Cardiac Diastole
- Both ventricles and atria relax at this stage of cardiac cycle.
- Atria get filled with blood and pressure increases.
- Ventricles are still relaxed.
- The blood flows into the ventricles and the whole process is repeated again.

Atherosclerosis
- It is a cardiovascular disease (CVD).
- In this disease, there is damage in the endothelial wall of the artery that gets clumped by white blood cells and fat. Accumulation of large numbers of white blood cells and fat leads to the formation of fibrous plaque. This is called as **atheroma**.
- The atheroma blocks the blood flow in the lumen and also causes increase in blood pressure.
- This condition in medical terms is known as **atherosclerosis**.
- It also increases the risk of **thrombosis**.
- It may also lead to increased risk of heart attack, stroke and other cardiovascular diseases.

Thrombosis (blood clotting)
- Blood clotting is very important as it prevents excessive loss of blood from the body.
- But if the blood clot takes place in the arteries, it can be life threatening as it may block the passage of blood and also increase blood pressure.
- Blood clotting process occurs in a series of steps:
  - ✓ Thromboplastin is released from the damaged blood vessel.
  - ✓ It converts prothrombin to thrombin.
  - ✓ Thrombin then converts fibrinogen to fibrin.
  - ✓ The fibers of fibrin entangle together and trap the red blood cells.
  - ✓ In this way a blood clot is formed.
- Blood clots can lead to heart attack, stroke and deep vein thrombosis.
- Any blockage by the blood clot in the coronary artery that supplies blood to the heart, may lead to a heart attack.
- Complete blockage cuts off oxygen and blood supply to the heart cells, causing cell death.

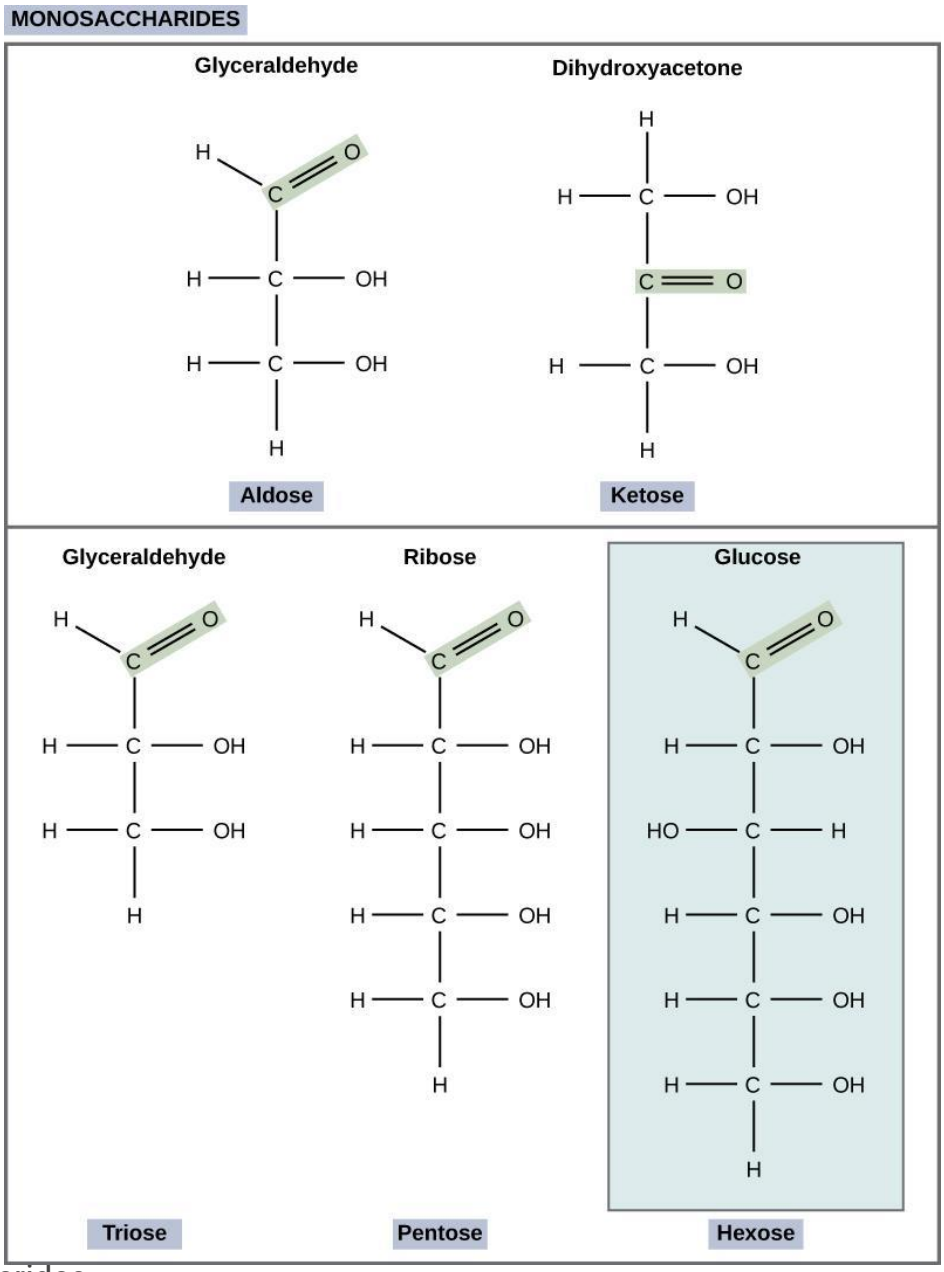
- If a blood clot occurs in the arteries that supply blood to the brain, it may lead to loss of brain functioning leading to a stroke.
- Another type of blood clot may occur in the leg veins. This is called deep vein thrombosis (DVT). It increases with the age of a person.

Factors that Increase the Risk of CVDs.

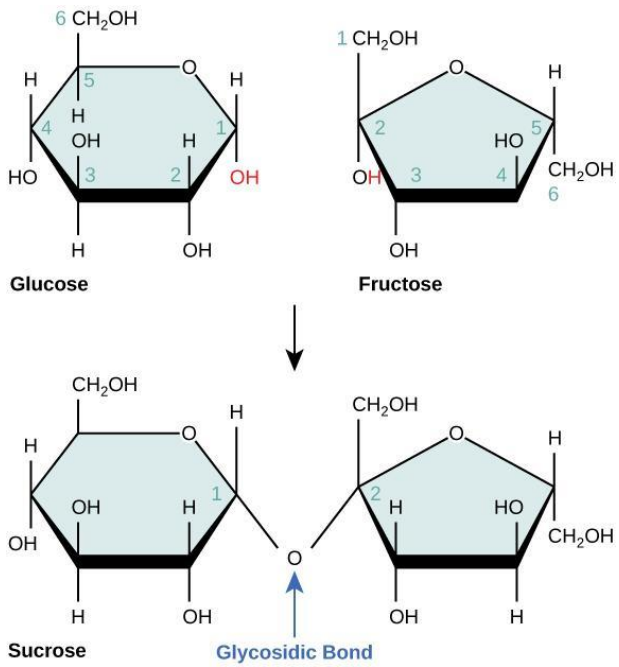
- **Lifestyle Factors**: The first and the foremost reason for any CVD is an unhealthy lifestyle. It includes:
  1. **Diet**: Eating too much saturated fat increases the level of cholesterol in the blood. It can also increase atheroma formation, which consequently leads to blood clotting and heart attack.
  2. **High Blood Pressure:** Another reason of heart diseases can be high blood pressure. It damages the arterial wall increasing the risk of atheroma formation.
  3. **Smoking**: Carbon monoxide in the cigarette smoke has high affinity for hemoglobin and it reduces the amount of oxygen in tissue. This can also lead to heart attack or stroke.
  4. **Sedentary lifestyle**: Lack of exercise and physical activities reduce the oxygen level in blood and also increases blood pressure.
- **Genetics**: Genes that we inherit from our parents also play an important role in disease. Family history of CVDs also increases the chances of CVDs.
- **Age**: It is an uncontrollable factor. With age the chances of CVDs increase.
- **Gender**: Males are more likely to have CVDs than females due to the hormonal changes.

Carbohydrates

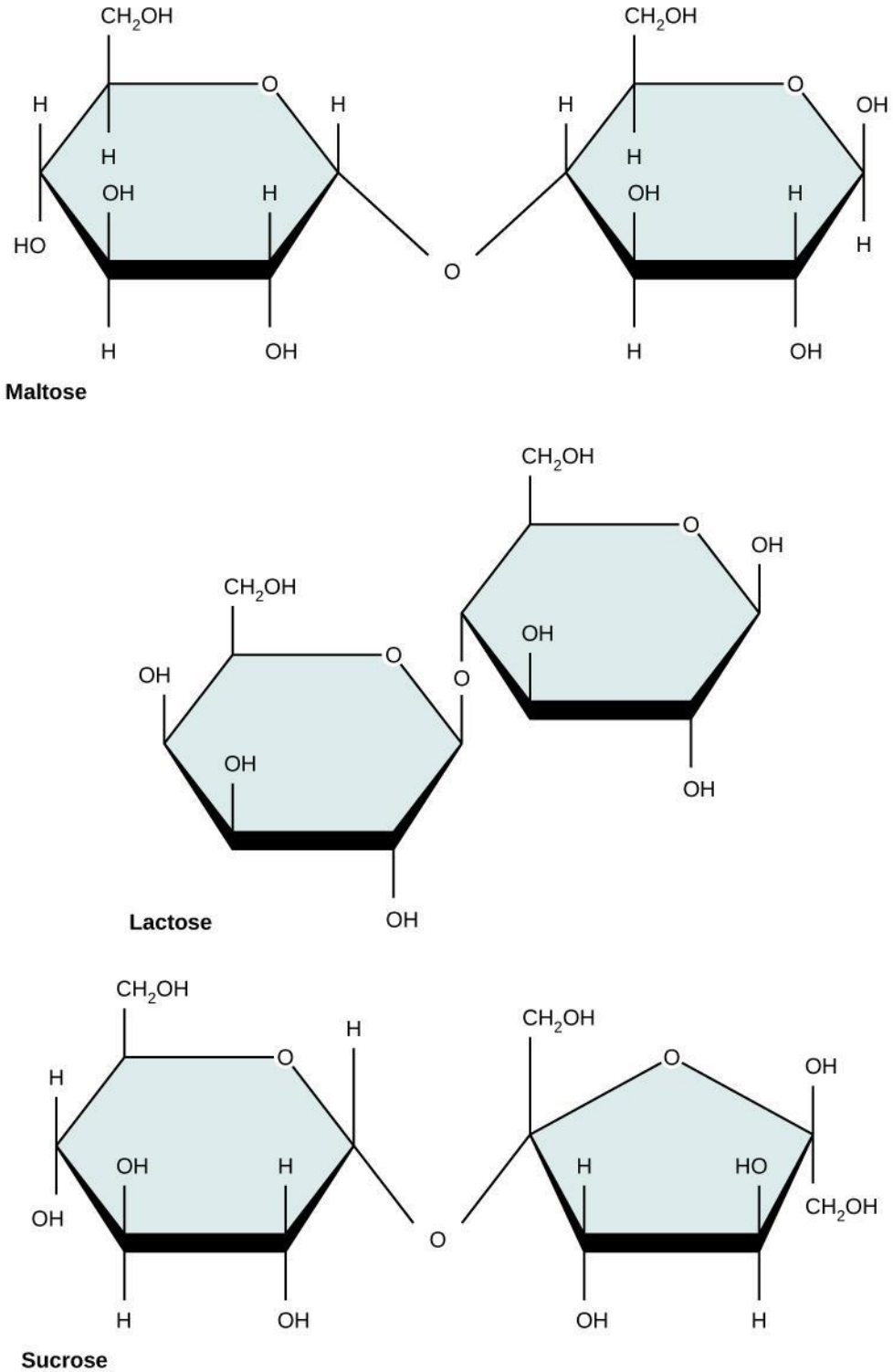
- These are organic molecules made up of hydrogen, oxygen and carbon.
- These are primarily found in food we eat.
- These are basic sources of energy that can vary from one molecule (monosaccharide) to chain of molecules (polysaccharides).
- Glucose is a monosaccharide and a basic energy source.
- Monosaccharides join together to form a disaccharide and then a polysaccharide. Two molecules are joined together by a glycosidic bond. It is a condensation reaction where a water molecule is released.
- Condensation reactions can be reversed. This is called hydrolysis.



Monosaccharides
Image Source: OpenStax CNX



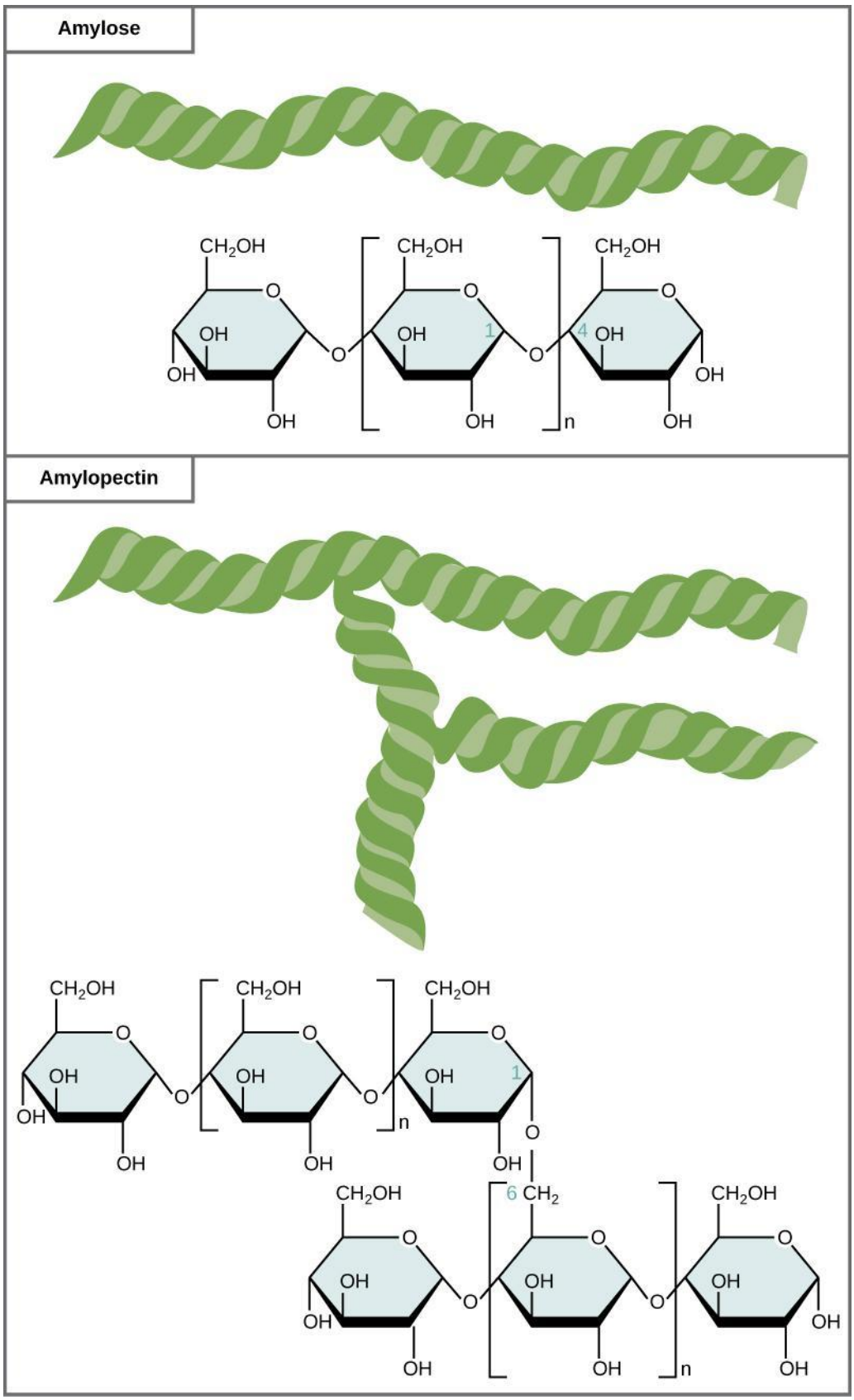
Glycosidic Bond Formation
Image Source: OpenStax CNX



Formation of Disaccharides
Image Source: OpenStax CNX

Two Important Polysaccharides

1. **Starch:**
   - It is a complex polysaccharide, which contain glucose as its structural unit.
   - Plants store energy in the form of starch.
   - It is made up of two chains: Amylose and amylopectin.



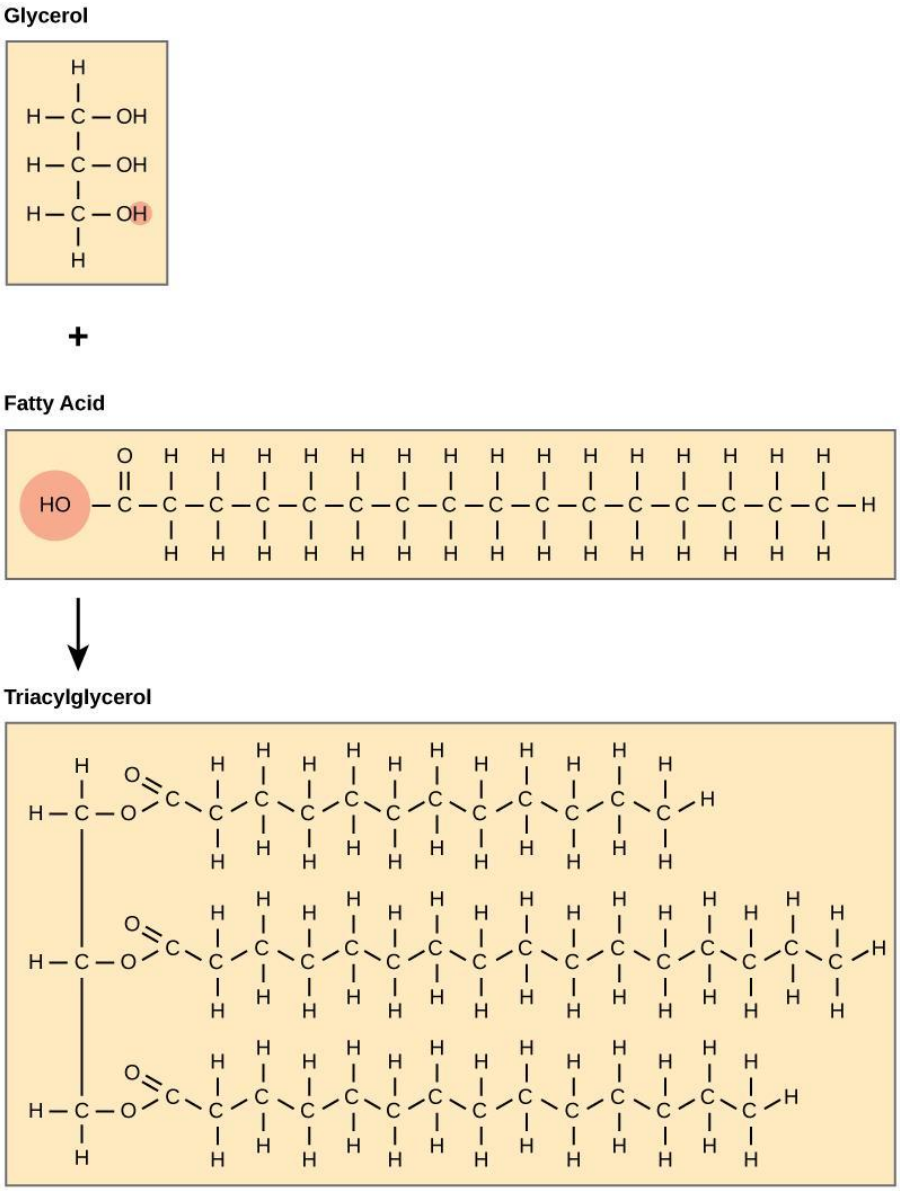
Amylose and Amylopectin Chains
Image Source: OpenStax CNX

- **Amylose**: It is an unbranched chain of glucose joined by alpha glycosidic bonds.
- **Amylopectin:** It is branched chain of glucose and contains 1-4 and 1-6 glycosidic bonds. It forms the side chains of the starch.

3. **Glycogen:**
   - These are food reserve in animals.
   - These are polymers of glucose linked by 1-4 and 1-6 glycosidic bonds.
   - It is similar to the structure of amylopectin.
   - It is insoluble in water.

Triglycerides

- These are lipids made up of one molecule of glycerol and three chains of fatty acids joined together by ester bonds.
- Fatty acids form the chains of triglycerides.
- The fatty acid tail is hydrophobic and insoluble in water.
- These are formed by condensation reaction.
- Breakage of ester bonds splits the triglycerides into fatty acids and glycerol.

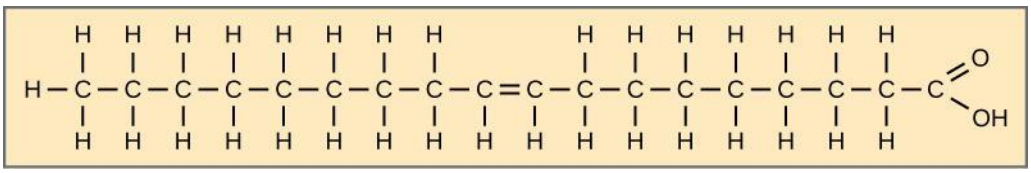


Formation of Triglycerides
Image Source: OpenStax CNX

Differences Between Saturated and Unsaturated Lipids

- Lipids are broadly classified into saturated lipids and unsaturated lipids.
- Saturated lipids are derived from animal fats and unsaturated lipids are obtained from plants.
- Saturated lipids do not melt at lower temperatures as with unsaturated lipids.
- Saturated lipids do not have double bonds in their hydrocarbon tail while unsaturated lipids have double bonds in their hydrocarbon tails.
- Due to double bonds, unsaturated lipids tend to be fluid in state unlike the saturated lipids.
- Saturated lipid is not good for health and it increases the risk of CVDs.

Structure of A Saturated Lipid
Image Source: OpenStax CNX



Structure of an Unsaturated Lipid
Image Source: OpenStax CNX

Blood Cholesterol and CVDs

- Cholesterol is a lipid which is not good for human body.
- It is made from saturated fats.
- For the movement of cholesterol, it should attach to a protein molecule and forms lipoproteins.
- There are two types of lipoproteins:
  1. **High Density Lipoproteins (HDLs):** These transport cholesterol from tissue to the liver for recycling. These reduce the level of cholesterol in blood when the level is high.
  2. **Low Density Lipoproteins (LDLs):** These are lipids that transport cholesterol from the liver to the blood. These increase the blood cholesterol when the level is low.
- High levels of HDL and cholesterol increase the chances of CVDs.
- Increase cholesterol also leads to atheroma formation.

How to Reduce the Risk of Coronary Heart Diseases

- There are various ongoing studies to reduce the risk of CVDs and other coronary heart diseases.
- Scientific studies have confirmed that change in lifestyle can reduce the risk of heart diseases.
- Diet rich in saturated fats increase the risk of heart diseases.

- Obese people also have high risk of CVDs. There are two obesity indicators such as BMI (Body Mass Index) and Waist to Hip ratio.
  BMI = Body mass (kg)/Height (sq m)
  Waist to Hip Ratio = Waist (cm)/Hip (cm)
- A normal adult has BMI between 18 and 25.
- Smoking is also related to high CVDs risk.
- People are advised to either quit smoking or use nicotine patches to reduce the risk.
- Research also confirms that exercise is the best way to prevent CVDs.

Ethical Issues and Use of Invertebrates in Experiments.

- There are many experiments and studies that are conducted on invertebrates. There are many medicines and their consequences that are first tested on invertebrates before human consumption.
- To some people and community it is unethical.
- The invertebrates used in researches are daphnia, spiders, etc. Some comment that their use is better than using vertebrates like rats, rabbits, etc.
- Some use invertebrates because these are simple organisms and possess similarities with humans.

Benefits and Risk Involved in Treating CVDs

Various drugs are used to treat cardiovascular diseases. Some of these are listed below:

- **Antihypertensives:** These medicines are used to reduce high blood pressure. These include beta-blockers and vasodilators. These drugs reduce the amount of sodium in the blood. These reduce the risk of atheromas and blood clotting. These also increase the rate of heart beat, headache, and drowsiness.
- **Statins**: These reduce the cholesterol level in blood. These reduce the risk of CVDs. These also include side effects such as muscle pain, diabetes, headaches and nose bleeding.
- **Anticoagulants:** These reduce the blood clotting. These reduce the risk of CVDs such as atheromas. These include the risk of excessive bleeding, allergic reactions, swelling, etc.
- **Platelet Inhibitory Drugs:** These include drug such as aspirin. These are anticoagulant. These also include the side effects such as rashes, nausea, excessive bleeding, etc.