

[Year]

**BIOLOGY INVESTIGATORY**  
**PROJECT**

★ **CARDIOVASCULAR DISEASES**

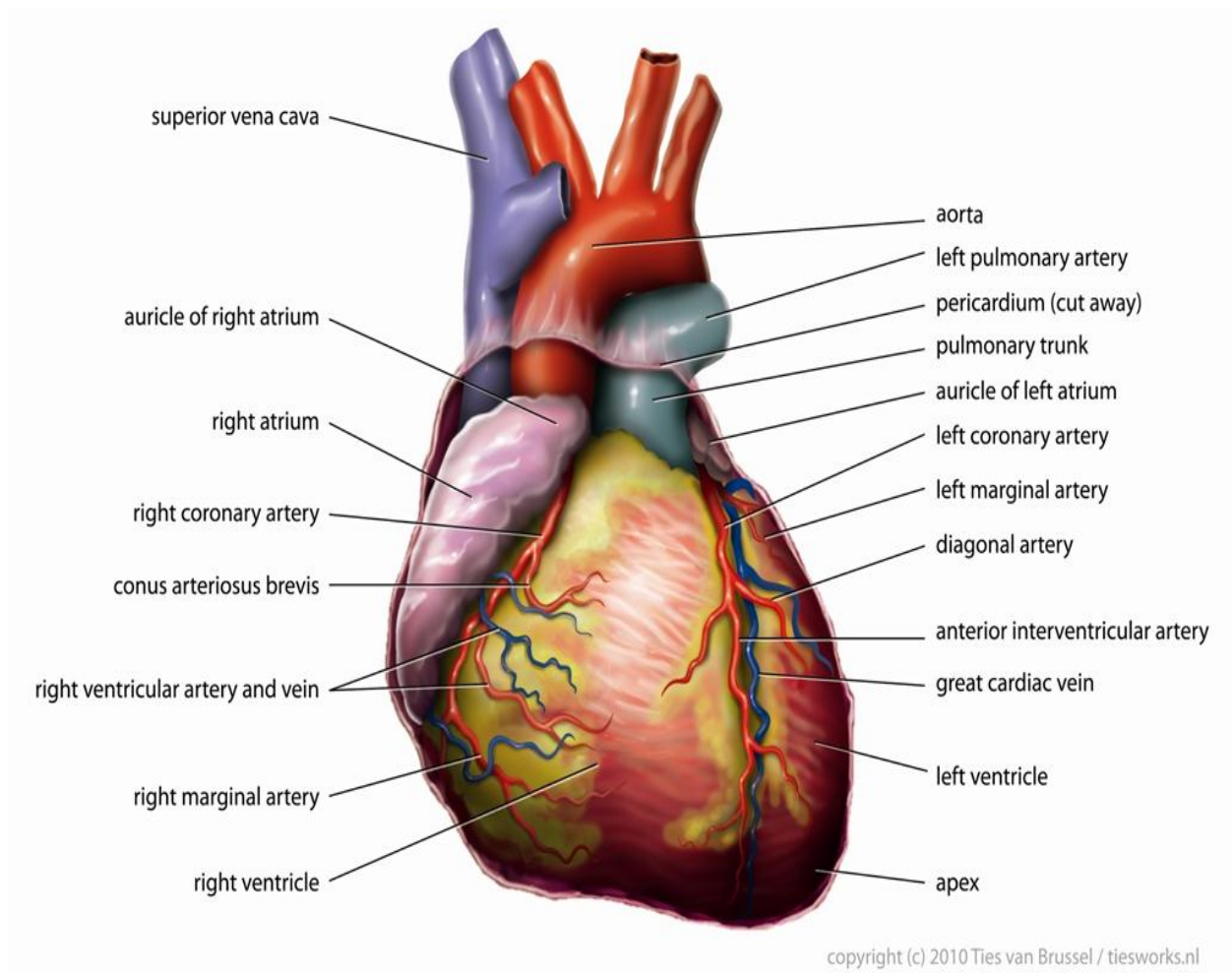
**SUBMITTED BY,**  
**M.KARTHIK**  
**XII**



# **HEART**

- ***The heart is a hollow muscle that pumps blood throughout the blood vessels by repeated, rhythmic contractions. It is found in all animals with a circulatory system (including all vertebrates).***
- ***The term cardiac (as in cardiology) means "related to the heart" and comes from the Greek καρδιά, kardia, for "heart".***
- ***The vertebrate heart is principally composed of cardiac muscle and connective tissue. Cardiac muscle is an involuntary striated muscle tissue found only in this organ and responsible for the ability of the heart to pump blood.***
- ***The average human heart, beating at 72 beats per minute, will beat approximately 2.5 billion times during an average 66 year lifespan. It weighs approximately 250 to 300 grams (9 to 11 oz) in females and 300 to 350 grams (11 to 12 oz) in males.***

# HUMAN HEART



# ***STRUCTURE***

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- ❖ *The structure of the heart can vary among the different branches of the animal kingdom Cephalopods have two "gill hearts" and one "systemic heart". In vertebrates, the heart lies in the anterior part of the body cavity, dorsal to the gut. It is always surrounded by a pericardium, which is usually a distinct structure, but may be continuous with the peritoneum in jawless and cartilaginous fish. Hagfishes, uniquely among vertebrates, also possess a second heart-like structure in the tail.*

## ***+ IN HUMANS***

- 1. The adult human heart has a mass of between 250 and 350 grams and is about the size of a fist. It is located anterior to the vertebral column and posterior to the sternum.*
- 2. It is enclosed in a double-walled sac called the pericardium. The superficial part of this sac is called the fibrous pericardium. This sac protects the heart, anchors its surrounding structures, and prevents overfilling of the heart with blood.*
- 3. The outer wall of the human heart is composed of three layers. The outer layer is called the epicardium, or visceral*

*pericardium since it is also the inner wall of the pericardium. The middle layer is called the myocardium and is composed of cardiac muscle which contracts. The inner layer is called the endocardium and is in contact with the blood that the heart pumps. Also, it merges with the inner lining (endothelium) of blood vessels and covers heart valves.*

- 4. The human heart has four chambers, two superior atria and two inferior ventricles. The atria are the receiving chambers and the ventricles are the discharging chambers. The pathway of blood through the human heart consists of a pulmonary circuit and a systemic circuit. Deoxygenated blood flows through the heart in one direction, entering through the superior vena cava into the right atrium and is pumped through the tricuspid valve into the right ventricle before being pumped out through the pulmonary valve to the pulmonary arteries into the lungs. It returns from the lungs through the pulmonary veins to the left atrium where it is pumped through the mitral valve into the left ventricle before leaving through the aortic valve to the aorta.*

## ***FUNCTIONING***

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- ❖ ***In mammals, the function of the right side of the heart (see right heart) is to collect de-oxygenated blood, in the right atrium, from the body (via superior and inferior vena cavae) and pump it, through the tricuspid valve, via the right ventricle, into the lungs (pulmonary circulation) so that carbon dioxide can be dropped off and oxygen picked up (gas exchange). This happens through the passive process of diffusion. The left side (see left heart) collects oxygenated blood from the lungs into the left atrium. From the left atrium the blood moves to the left ventricle, through the bicuspid valve (mitral valve), which pumps it out to the body (via the aorta). On both sides, the lower ventricles are thicker and stronger than the upper atria. The muscle wall surrounding the left ventricle is thicker than the wall surrounding the right ventricle due to the higher force needed to pump the blood through the systemic circulation.***
  
- ❖ ***Starting in the right atrium, the blood flows through the tricuspid valve to the right ventricle. Here, it is pumped out the pulmonary semilunar valve and travels through the pulmonary artery to the lungs. From there, oxygenated blood flows back through the pulmonary vein to the left atrium. It then travels through the mitral valve to the left ventricle, from where it is pumped through the aortic semilunar valve to the aorta. The aorta forks and the blood is divided between major arteries which supply the upper and lower body. The blood travels in the***

*arteries to the smaller arterioles and then, finally, to the tiny capillaries which feed each cell. The (relatively) deoxygenated blood then travels to the venules, which coalesce into veins, then to the inferior and superior venae cavae and finally back to the right atrium where the process began.*

- ❖ *Cardiac arrest is the sudden cessation of normal heart rhythm which can include a number of pathologies such as tachycardia, an extremely rapid heart beat which prevents the heart from effectively pumping blood, which is an irregular and ineffective heart rhythm, and asystole, which is the cessation of heart rhythm entirely.*
- ❖ *Cardiac tamponade is a condition in which the fibrous sac surrounding the heart fills with excess fluid or blood, suppressing the heart's ability to beat properly. Tamponade is treated by pericardiocentesis, the gentle insertion of the needle of a syringe into the pericardial sac (avoiding the heart itself) on an angle, usually from just below the sternum, and gently withdrawing the tamponading fluids.*
- ❖ *The valves of the heart were discovered by a physician of the Hippocratean school around the 4th century BC, although their function was not fully understood.*
- ❖ *Ancient anatomists subsequently assumed they were filled with air and served to transport it around the body.*
- ❖ *Philosophers distinguished veins from arteries, but thought the pulse was a property of arteries themselves.*

# ***CARDIOVASCULAR DISEASE***

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- ***Cardiovascular disease is a class of diseases that involve the heart or blood vessels (arteries, capillaries and veins).***
- ***Cardiovascular disease refers to any disease that affects the cardiovascular system, principally cardiac disease, vascular diseases of the brain and kidney, and peripheral arterial disease. The causes of cardiovascular disease are diverse but atherosclerosis and/or hypertension are the most common. Besides, with aging come a number of physiological and morphological changes that alter cardiovascular function and lead to subsequently increased risk of cardiovascular disease, even in healthy asymptomatic individuals.***
- ***Cardiovascular diseases remain the biggest cause of deaths worldwide, though over the last two decades, cardiovascular mortality rates have declined in many high-income countries. At the same time, cardiovascular deaths and disease have increased at a fast rate in low- and middle-income countries. Although cardiovascular disease usually affects older adults, the antecedents of cardiovascular disease, notably atherosclerosis, begin in early life, making primary prevention efforts necessary from childhood.***



## ❖ **RISK FACTORS**

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***Epidemiology suggests a number of risk factors for heart disease: age, gender, high blood pressure, high serum cholesterol levels, tobacco smoking, excessive alcohol consumption, family history, obesity, lack of physical activity, psychosocial factors, diabetes mellitus, air pollution. While the individual contribution of each risk factor varies between different communities or ethnic groups the consistency of the overall contribution of these risk factors to epidemiological studies is remarkably strong. Some of these risk factors, such as age, gender or family history, are immutable; however, many important cardiovascular risk factors are modifiable by lifestyle change, drug treatment or social change.***

### ➤ **AGE**

- ***Age is an important risk factor in developing cardiovascular diseases. It is estimated that 87 percent of people who die of coronary heart disease are 60 and older. At the same time, the risk of stroke doubles every decade after age 55.***
- ***Multiple explanations have been proposed to explain why age increases the risk of cardiovascular diseases. One of them is related to serum cholesterol level. In most populations, the serum total cholesterol level increases as***

*age increases. In men, this increase levels off around age 45 to 50 years. In women, the increase continues sharply until age 60 to 65 years.*

- *Aging is also associated with changes in the mechanical and structural properties of the vascular wall, which leads to the loss of arterial elasticity and reduced arterial compliance and may subsequently lead to coronary artery disease.*

### ➤ **SEX**

- *Men are at greater risk of heart disease than pre-menopausal women. However, once past menopause, a woman's risk is similar to a man's.*
- *Among middle-aged people, coronary heart disease is 2 to 5 times more common in men than in women. In a study done by the World Health Organization, sex contributes to approximately 40% of the variation in the sex ratios of coronary heart disease mortality. Another study reports similar results that gender difference explains nearly half of the risk associated with cardiovascular diseases. One of the proposed explanations for the gender difference in cardiovascular disease is hormonal difference.*
- *Among men and women, there are differences in body weight, height, body fat distribution, heart rate.*

# **HEART ATTACK**

***A heart attack occurs when blood flow to a part of your heart is blocked for a long enough time that part of the heart muscle is damaged or dies. The medical term for this is myocardial infarction***

## **CAUSES, INCIDENCE, AND RISK FACTORS**

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- ***Most heart attacks are caused by a blood clot that blocks one of the coronary arteries. The coronary arteries bring blood and oxygen to the heart. If the blood flow is blocked, the heart is starved of oxygen and heart cells die.***
- ***A hard substance called plaque can build up in the walls of your coronary arteries. This plaque is made up of cholesterol and other cells.***
- ***A heart attack may occur when:***
  - 1) Blood platelets stick to tears in the plaque and form a blood clot that blocks blood from flowing to the heart. This is the most common cause of heart attacks.***
  - 2) A slow buildup of this plaque may almost block one of your coronary arteries.***

- 3) The cause of heart attacks is not always known. Heart attacks may occur:**
- 4) When you are resting or asleep**
- 5) After a sudden increase in physical activity**
- 6) When you are active outside in cold weather**
- 7) After sudden, severe emotional or physical stress, including an illness**

## ***SYMPTOMS***

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- + A heart attack is a medical emergency. If you have symptoms of a heart attack, call 911 or your local emergency number right away.**
- + DO NOT try to drive yourself to the hospital.**
- + DO NOT WAIT. You are at greatest risk of sudden death in the early hours of a heart attack.**
- + Chest pain is the most common symptom of a heart attack. You may feel the pain in only one part of your body, or it may move from your chest to your arms, shoulder, neck, teeth, jaw, belly area, or back.**
- + The pain can be severe or mild. It can feel like:**
  - + A tight band around the chest**
  - + Bad indigestion**
  - + Something heavy sitting on your chest**

### ***OTHER SYMPTOMS OF A HEART ATTACK CAN INCLUDE:***

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- + Anxiety**
- + Cough**
- + Fainting**
- + Light-headedness, dizziness**
- + Nausea or vomiting**
- + Palpitations (feeling like your heart is beating too fast or irregularly)**
- + Shortness of breath**
- + Sweating, which may be very heavy**
- + Some people (the elderly, people with diabetes, and women) may have little or no chest pain. Or, they may have unusual symptoms (shortness of breath, fatigue, and weakness). A "silent heart attack" is a heart attack with no symptoms.**

### ***TESTS TO LOOK AT YOUR HEART THAT MAY BE DONE WHILE YOU ARE IN THE HOSPITAL:***

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- + *Echocardiography***
- + *Exercise stress test***
- + *Nuclear stress test***

## ***SIGNS AND TESTS***

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- + A doctor or nurse will perform a physical exam and listen to your chest using a stethoscope.***
- + The doctor may hear abnormal sounds in your lungs (called crackles), a heart murmur, or other abnormal sounds.***
- + You may have a fast or uneven pulse.***
- + Your blood pressure may be normal, high, or low.***
- + You will have an electrocardiogram (ECG) to look for heart damage. A troponin blood test can show if you have heart tissue damage. This test can confirm that you are having a heart attack.***
- + Coronary angiography may be done right away or when you are more stable.***
- + This test uses a special dye and x-rays to see how blood flows through your heart.***
- + It can help your doctor decide which treatments you need next.***

## ***WHEN YOU ARE IN THE EMERGENCY ROOM:***

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- + You will be hooked up to a heart monitor, so the health care team can look at how your heart is beating.***
- + You will receive oxygen so that your heart doesn't have to work as hard.***
- + You may get nitroglycerin and morphine to help reduce chest pain.***
- + You may receive aspirin, unless it would not be safe for you. In that case, you will be given another medicine that prevents blood clots.***
- + Dangerous abnormal heartbeats (arrhythmias) may be treated with medicine or electric shocks.***

## ***EMERGENCY TREATMENTS***

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- + Angioplasty is a procedure to open narrowed or blocked blood vessels that supply blood to the heart.***
- + Angioplasty is often the first choice of treatment. It should be done within 90 minutes after you get to the hospital, and no later than 12 hours after a heart attack.***
- + A stent is a small, metal mesh tube that opens up (expands) inside a coronary artery. A stent is often placed after angioplasty. It helps prevent the artery from closing up again.***

- + You may be given drugs to break up the clot. It is best if these drugs are given within 3 hours of when you first felt the chest pain. This is called thrombolytic therapy.**
- + Some patients may also have heart bypass surgery to open narrowed or blocked blood vessels that supply blood to the heart. This procedure is also called open heart surgery.**
- + AFTER YOUR HEART ATTACK**
- + After several days, you will be discharged from the hospital.**
- + You will likely need to take medicines, possibly for the rest of your life. Always talk to your health care provider before stopping or changing how you take any medicines.**

## ***HEART DISEASE MEDICATIONS***

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***The purpose of medications for coronary artery disease is to allow more efficient heart muscle function to overcome any blockage that might exist.***

- + Aspirin is one of the cornerstones of coronary artery disease treatment. It prevents platelets from clumping together when blood becomes turbulent, like when it flows past a narrowing in an artery.**



- + Beta blockers prevent the action of adrenaline on the heart and allow the heart to beat a more efficiently by reducing the heart rate and causing the heart muscle to contract less aggressively.**
- + Antiarrhythmia drugs help keep abnormal heart rhythms under control.**
- + Antiplatelet drugs prevent blood clots. That's a good thing for people at risk of heart disease.**
- + Digoxin is a medication that helps an injured or weakened heart work more efficiently to send blood through the body. It strengthens the force of the heart muscle's contractions, slows the heart rate, and improves blood circulation.**
- + Nitrates are vasodilators that are used to treat angina in people with coronary artery disease or chest pain caused by blocked blood vessels of the heart. They work to control angina by relaxing the coronary arteries so blood can flow more easily to the heart.**
- + Nitrates can be used with another blood pressure medication (hydralazine) to treat congestive heart failure.**

## ***WORLD HEART DAY***

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- + World Heart Day takes place on 29 September each year: Together with its members, the World Heart Federation spreads the news that at least 80% of premature deaths from heart disease and stroke could be avoided if the main risk factors, tobacco, unhealthy diet and physical inactivity**

# ***AMAZING HEART FACTS***

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- + The heart weighs less than one pound. The average weight for women is eight ounces and for men, 10 ounces.***
- + The heart beats about 100,000 times each day.***
- + When you sneeze, all your bodily functions stop even your heart.***
- + The Strong Contraction of Your Heart Creates Enough Pressure To Squirt Blood As Far As 30 Feet***
- + Every day, your heart beats about 100,000 times, sending 2,000 gallons of blood surging through your body.***
- + Your heart beats about 100,000 times in one day and about 35 million times in a year. During an average lifetime, the human heart will beat more than 2.5 billion times.***
- + Because the heart has its own electrical impulse, it can continue to beat even when separated from the body, as long as it has an adequate supply of oxygen.***
- + The heart begins beating at four weeks after conception and does not stop until death.***
- + Cocaine affects the heart's electrical activity and causes spasm of the arteries, which can lead to a heart attack or stroke, even in healthy people***
- + Prolonged lack of sleep can cause irregular jumping heartbeats called premature ventricular contractions (PVCs).***
- + A woman's heart typically beats faster than a man's. The heart of an average man beats approximately 70 times a minute, whereas the average woman has a heart rate of 78 beats per minute.***





