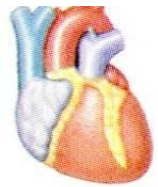


# THE CIRCULATORY SYSTEM

The Body's Transport System



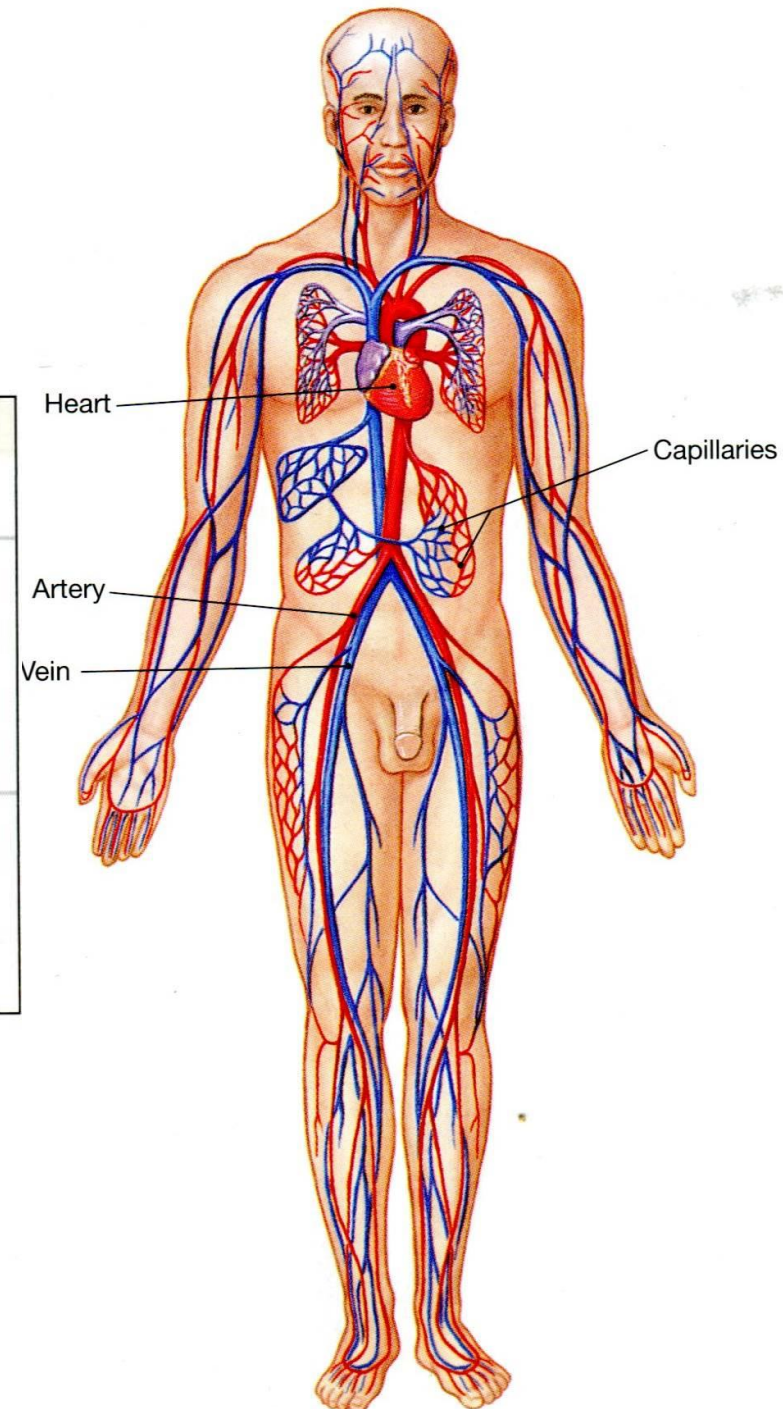
COMPILED BY HOWIE BAUM



## (f) THE CARDIOVASCULAR SYSTEM

Transports cells and dissolved materials, including nutrients, wastes, and gases

Organ/Component	Primary Functions
<b>Heart</b>	Propels blood; maintains blood pressure
<b>Blood Vessels</b>	Distribute blood around the body
<b>Arteries</b>	Carry blood from heart to capillaries
<b>Capillaries</b>	Permit diffusion between blood and interstitial fluids
<b>Veins</b>	Return blood from capillaries to the heart
<b>Blood</b>	Transports oxygen, carbon dioxide, and blood cells; delivers nutrients and hormones; removes waste products; assists in temperature regulation and defense against disease



**The circulatory system, sometimes called the cardiovascular system, consists of the heart, blood vessels, and blood.**

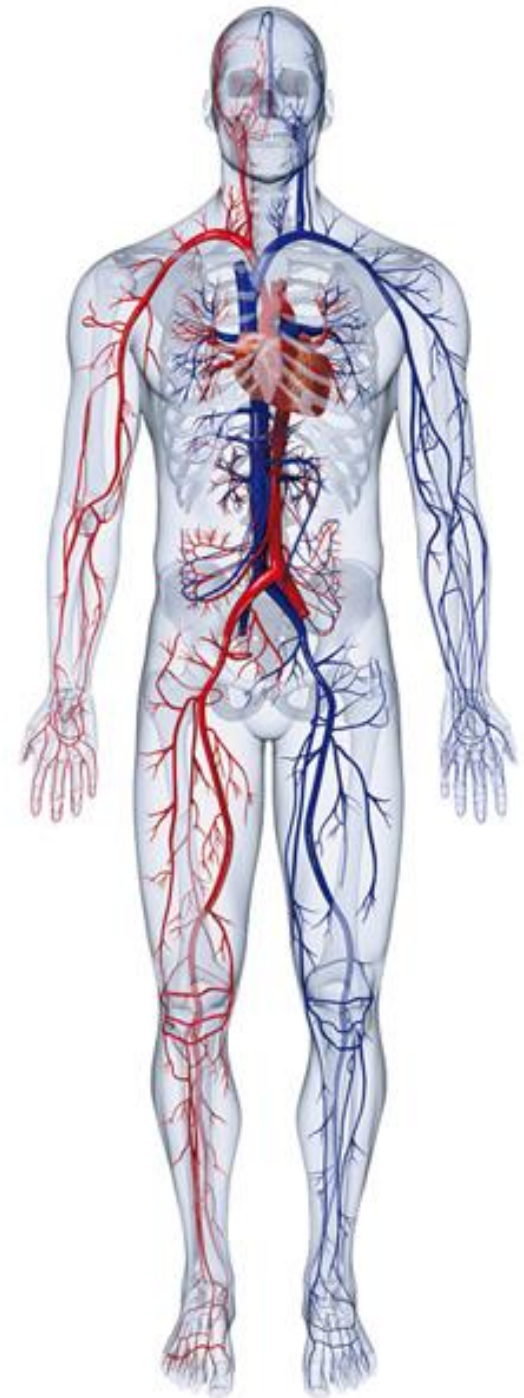
**It transports oxygen, hormones and nutrients to all the cells in the body**

**It picks up waste products generated by metabolic processes and delivers them to other organs for disposal.**

**The heart provides the "muscle" needed to pump blood throughout the body.**

**The system circulates blood in two circuits:**

**The Pulmonary circuit and Systemic circuit.**

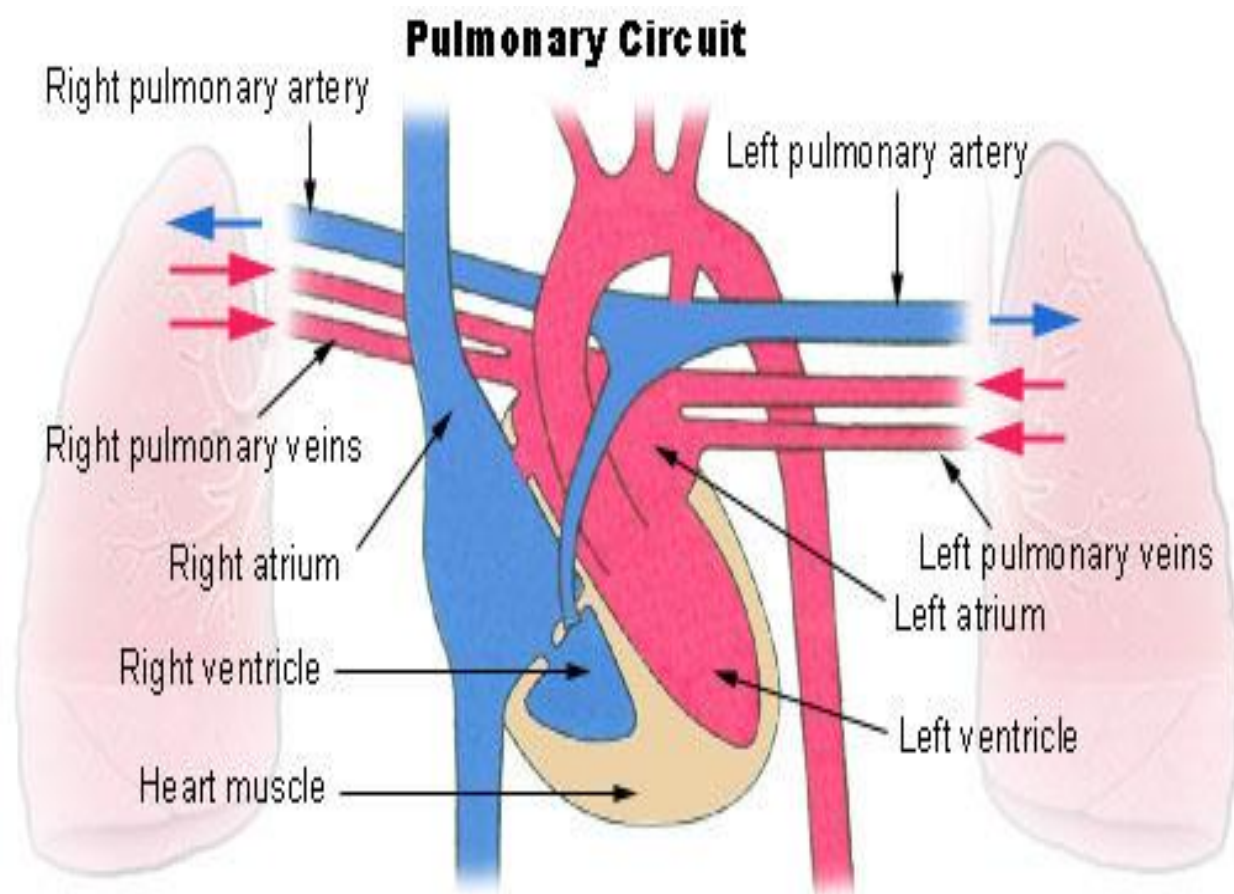


# PULMONARY CIRCULATION

**Heart:** your heart pumps blood through two major pathways.

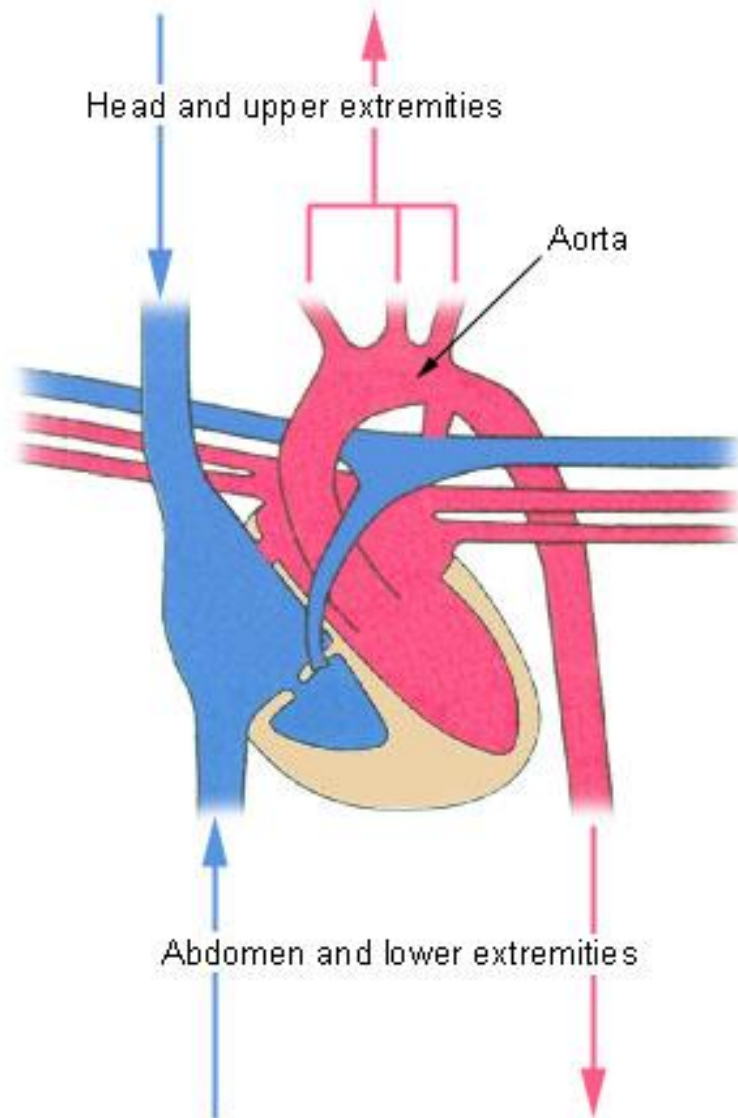
## 1) Pulmonary circulation

Transports oxygen-poor blood from the right ventricle to the lungs where blood picks up a new oxygen supply.



# SYSTEMIC CIRCULATION

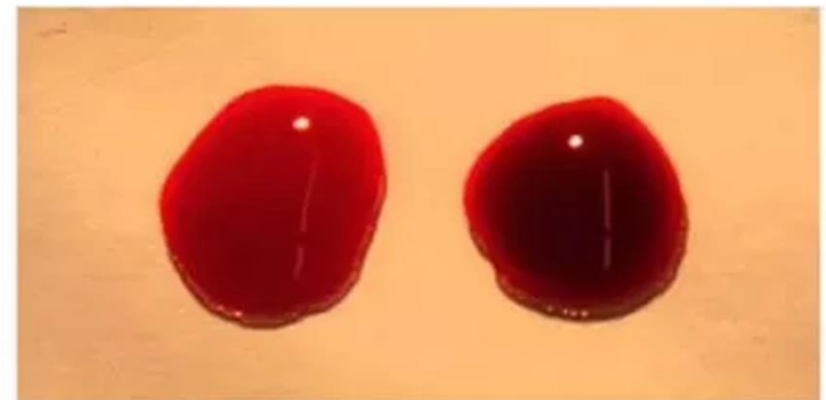
## Systemic Circuit



## 2) Systemic circulation

It returns oxygen rich blood and nutrients to the left atrium and is pumped out all over the body

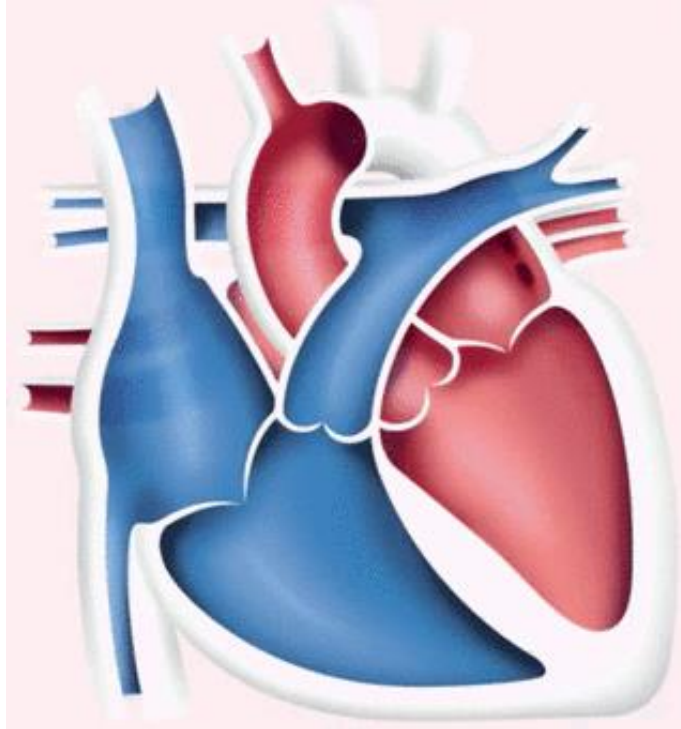
It also picks up carbon dioxide and other waste products.



Oxygenated  
blood: **Bright red**

Deoxygenated  
blood:  
**Deep red-purple**

Oxygen-poor blood enters the heart from the body (blue, top left) and is pumped out to the lungs (blue, top right)



Oxygen-rich blood enters the heart from the lungs (red, right side) and is pumped out to the body (top)

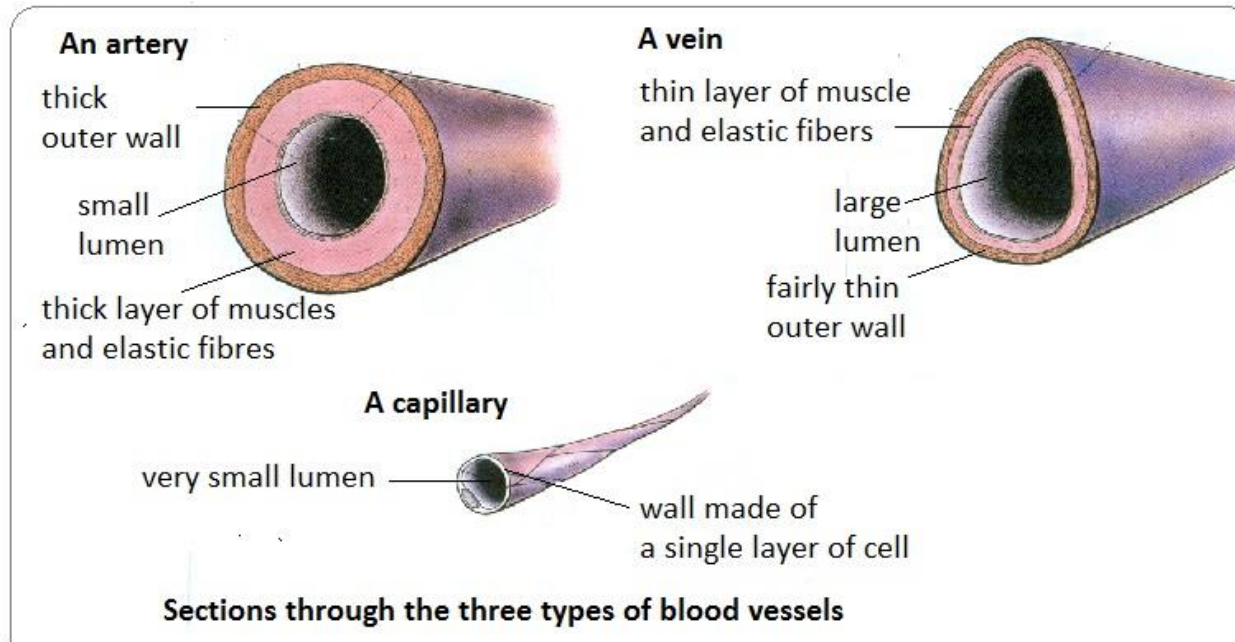
- **Hormones** from glands help regulate cell activity.
- **Oxygen** from the lungs combines with nutrients to provide energy.
- **Nutrients** from the digestive system provide food for the cells.

# THE CIRCULATORY SYSTEM WORKS IN CONJUNCTION WITH OTHER BODY SYSTEMS, TO KEEP IT WORKING PROPERLY.

- ❖ When your blood circulates through your **digestive system**, it picks up nutrients your body absorbed from your last meal.
- ❖ **Your blood also carries oxygen inhaled by the lungs.** Your circulatory system delivers oxygen and nutrients to your heart and the other cells of your body then picks up any waste products created by these cells, including carbon dioxide, and **delivers these waste products to the kidneys and lungs for disposal.**
- ❖ The circulatory system carries **hormones from the endocrine system**, and the immune system's white blood cells that fight off infection.
- ❖ The circulatory system provides your **brain** with a constant supply of oxygen-rich blood while your brain regulates your heart rate and blood pressure.
- ❖ Your circulatory system delivers oxygen-rich blood to your **bones**. Meanwhile, your bones are busy making new blood cells.

**BLOOD VESSELS** - Over 60,000 miles of blood vessels transport your blood throughout your body. There are 3 types of blood vessels.

- **Arteries:** Blood vessels that carry blood away from the heart to other parts of the body. They are much thicker than Veins because of the high pressure of blood coming from the heart.
- **Veins:** Blood vessels that carry blood from the body back to the heart.
- **Capillaries:** Tiny tubes that carry blood from the arteries to the body's cells, and then back to the veins.



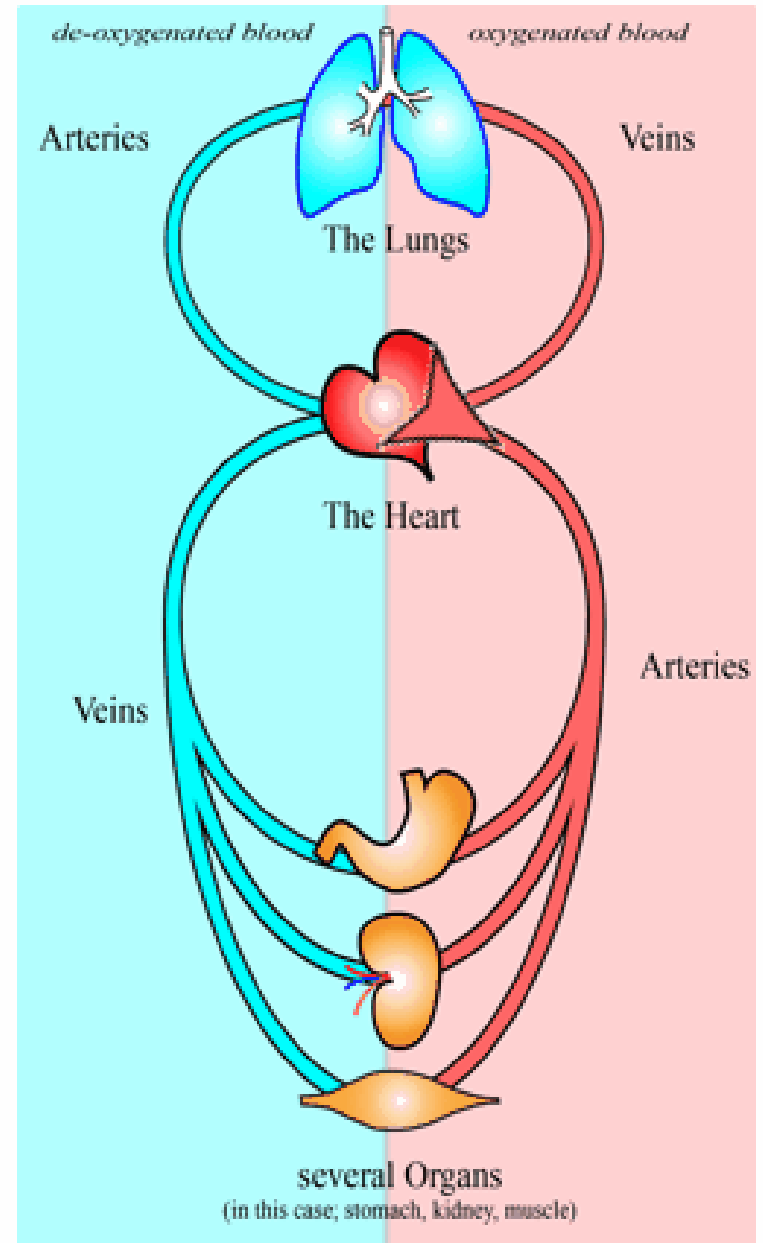
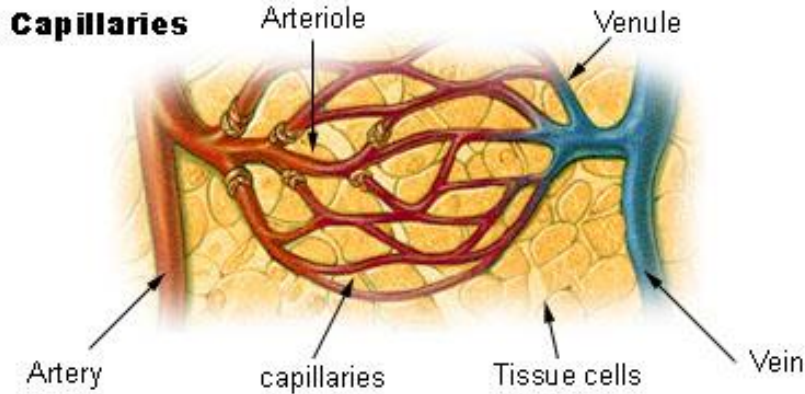
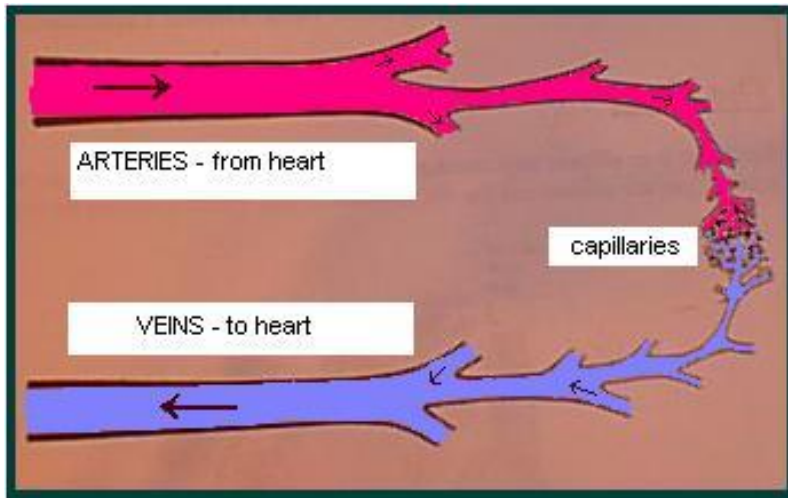


# CAPILLARIES

- Body tissues contain a vast network of thin capillaries.
- Capillary walls are only one cell thick, allowing exchange of gases, nutrients, and wastes.
- Capillaries are so fine that red blood cells must line up single-file to go through them.



# ARTERIES, VEINS, AND CAPILLARIES



# ❖ BLOOD

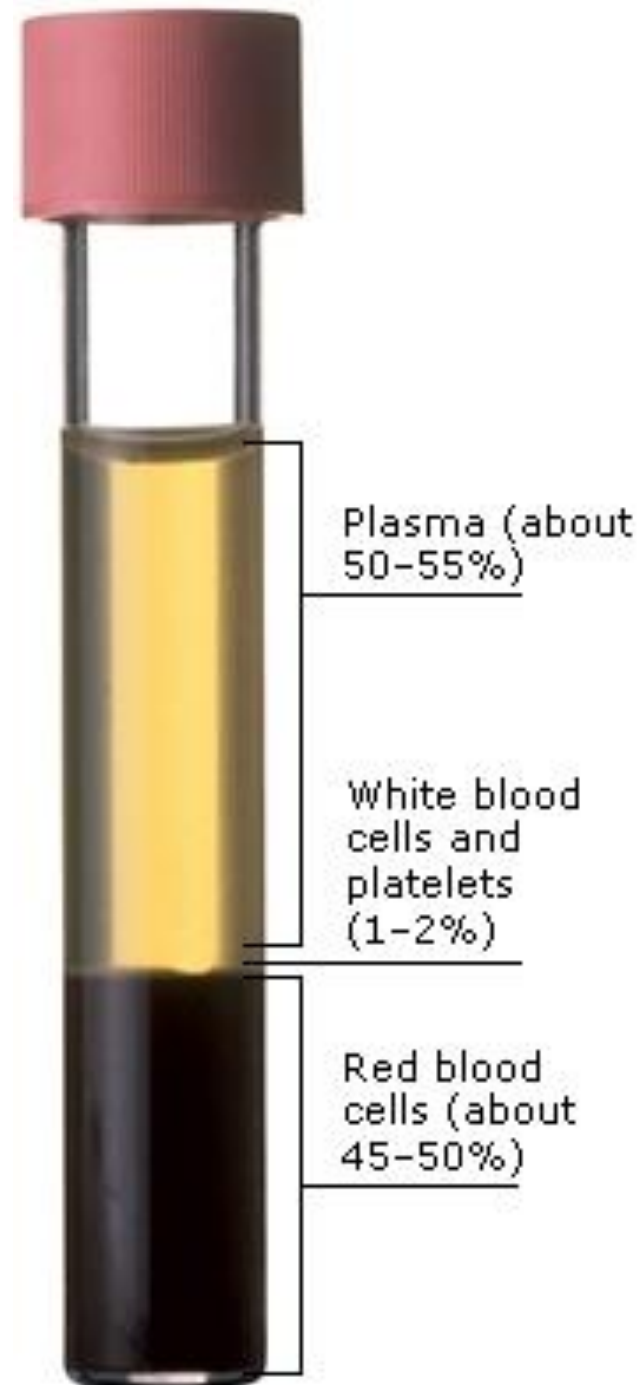
Blood forms about one-twelfth of the body weight of an adult, amounting to about 5 liters (11 pints) in volume.

45% – 50% is red Blood Cells

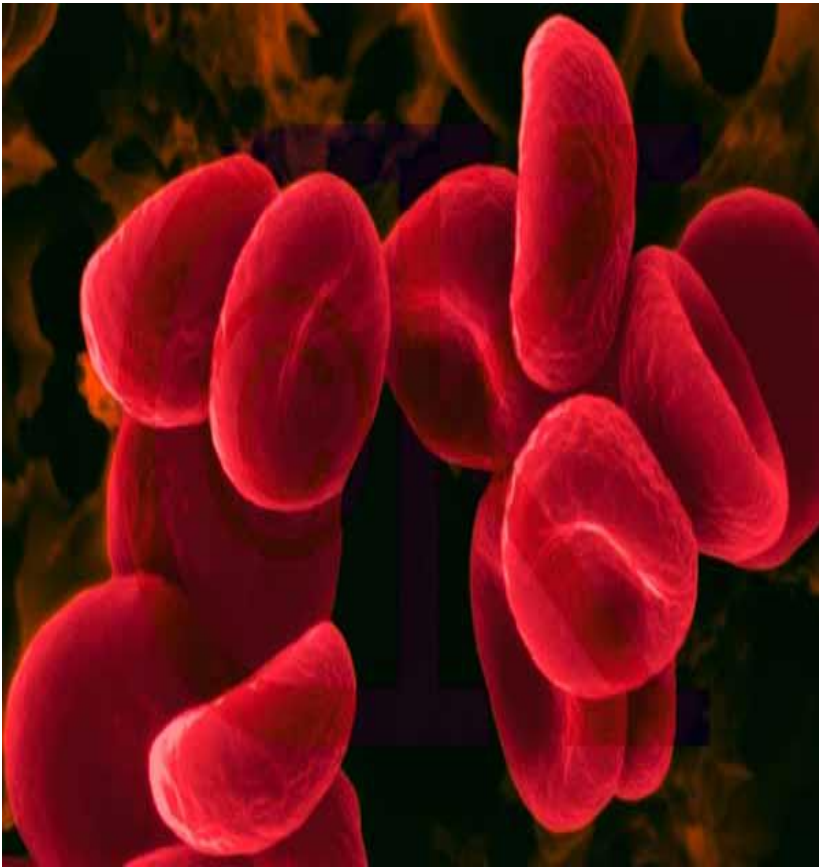
Roughly 50–55 % of blood is plasma, the liquid-only portion in which cellular components are distributed.

Plasma contains 90 per cent water with dissolved substances such as glucose (blood sugar), hormones, enzymes, and also waste products such as urea and lactic acid.

Plasma also contains proteins such as albumin, fibrinogen (important in clotting), and globular proteins or globulins.

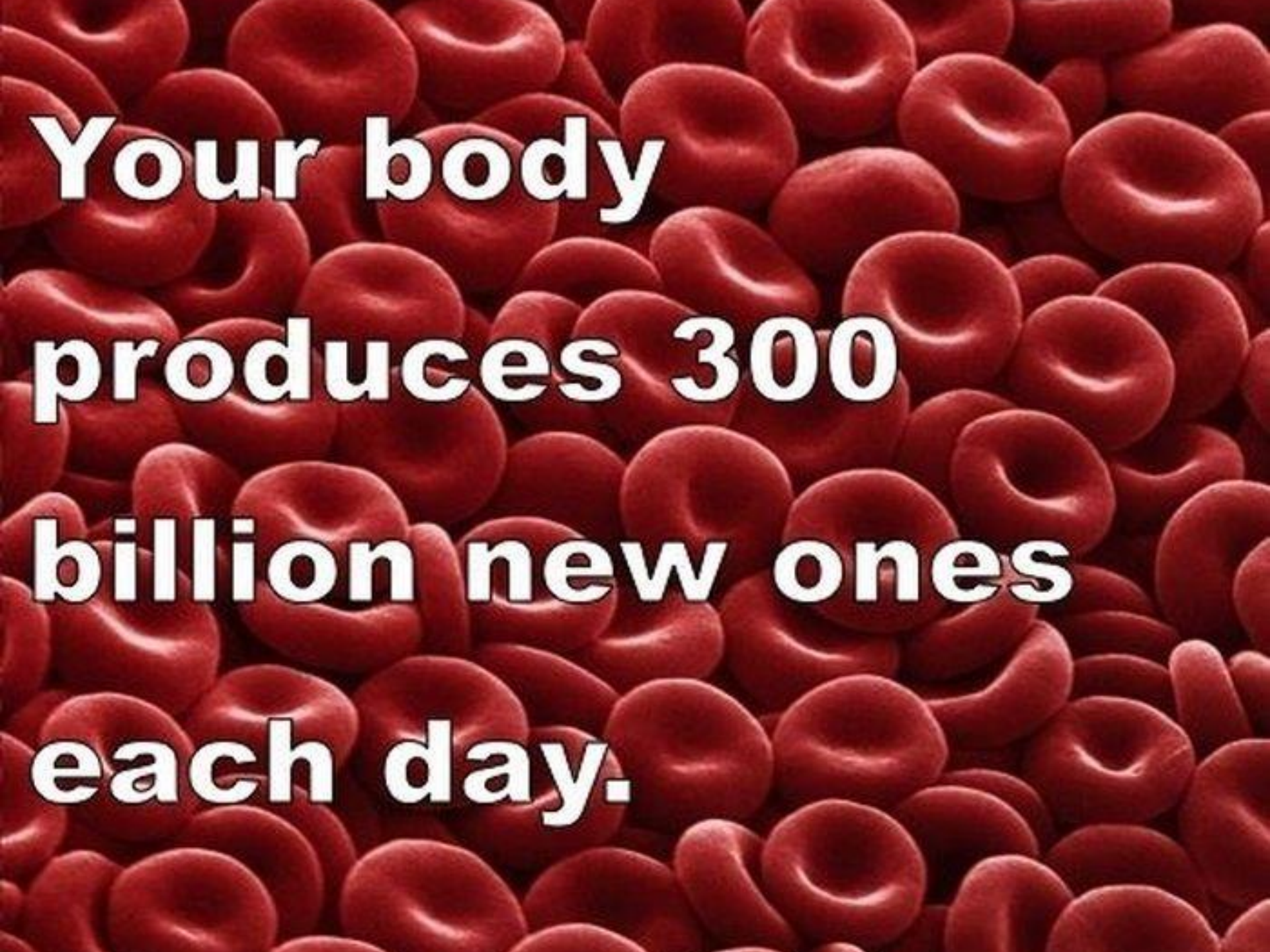


# RED BLOOD CELLS (ERYTHROCYTES)



Their shape is described as Bio-Concave as they have depressions on both sides, so they have a maximum amount of surface to absorb oxygen from the lungs

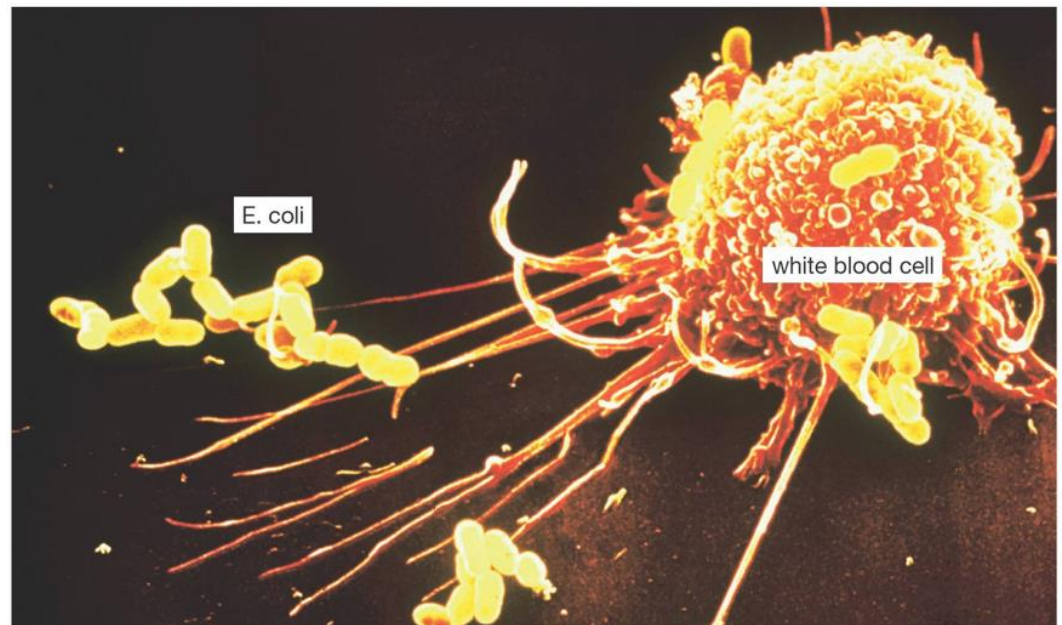
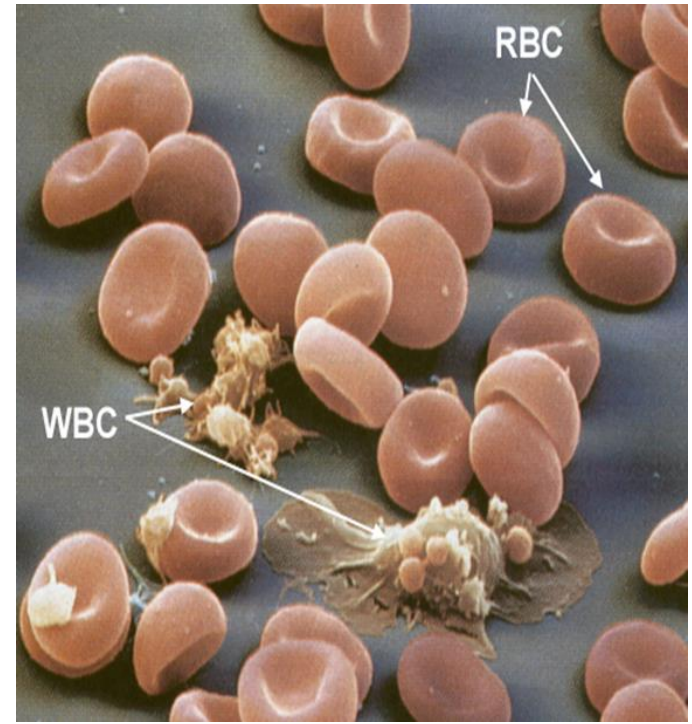
- ◎ They are Transporters of
  - Oxygen
  - Carbon Dioxide
- ◎ Red Blood Cells
  - Lack a nucleus
  - Contain hemoglobin
  - Disk-shaped
- ◎ They are produced in red bone marrow of the:
  - ribs
  - Humerus (upper arm bone)
  - Femur (upper leg bone)
  - sternum, and other long bones
- ◎ They live for 120 days
- ◎ Old red blood cells are destroyed in the liver and spleen



**Your body  
produces 300  
billion new ones  
each day.**

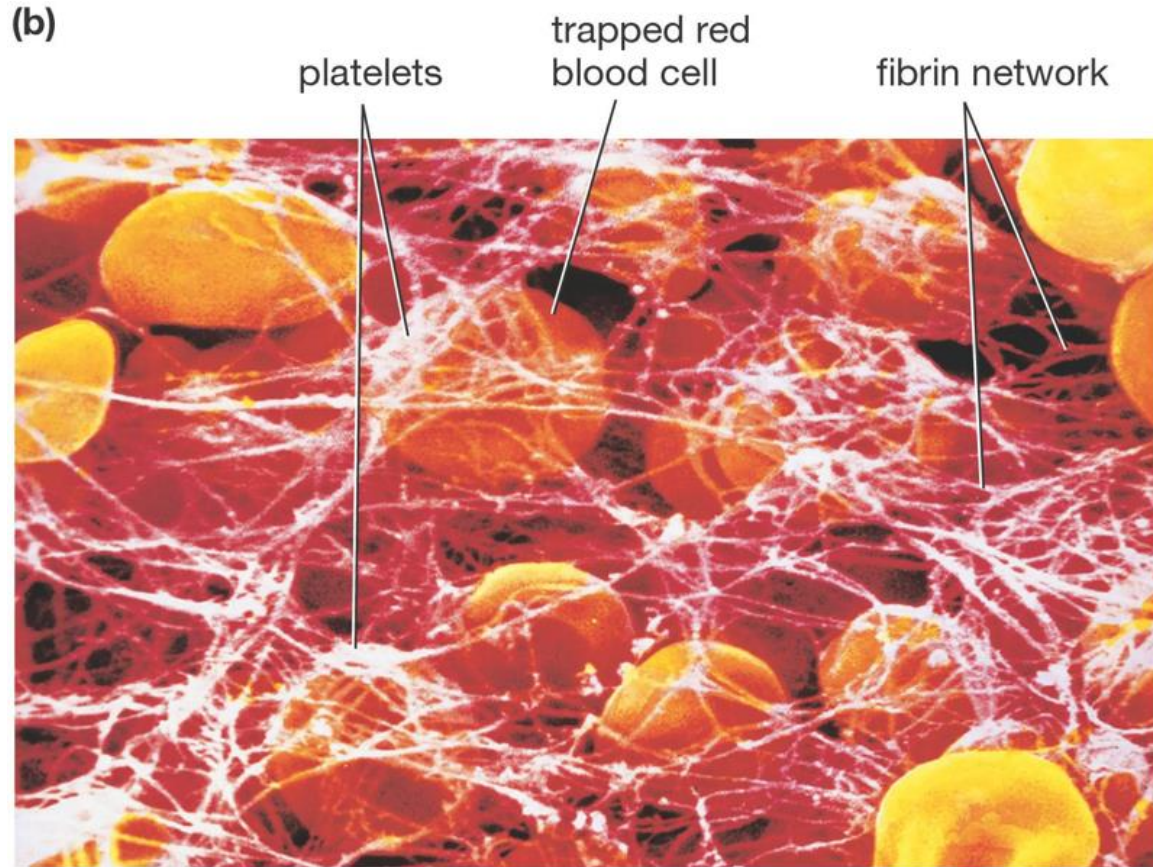
# WHITE BLOOD CELLS

- White blood cells defend against disease by recognizing proteins that do not belong to the body.
- They are able to ooze through the walls of capillaries to patrol the tissues and reach the lymph system.



# PLATELETS

- Platelets are cell fragments used in blood clotting.
- They are derived from megakaryocytes.
- Because they lack a nucleus, platelets have a short lifespan, usually about 10 days.



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**White blood cell**

Also called leucocytes, white blood cells are a vital part of the body's defence system.

**Platelet**

Tiny, short-lived cell fragment that has an important role in the clotting of blood.

**Red blood cell**

Red blood cells (erythrocytes) have a lifespan of around 3 months.

**Blood vessel wall**

The thickness of the wall is dependent on the pressure of the blood flowing through it.



# THE 4 BLOOD TYPES

The Rhesus (**Rh**) factor is an inherited protein found on the surface of red **blood** cells.

If your **blood** has the protein, you're **Rh** positive. If your **blood** lacks the protein, you're **Rh** negative.

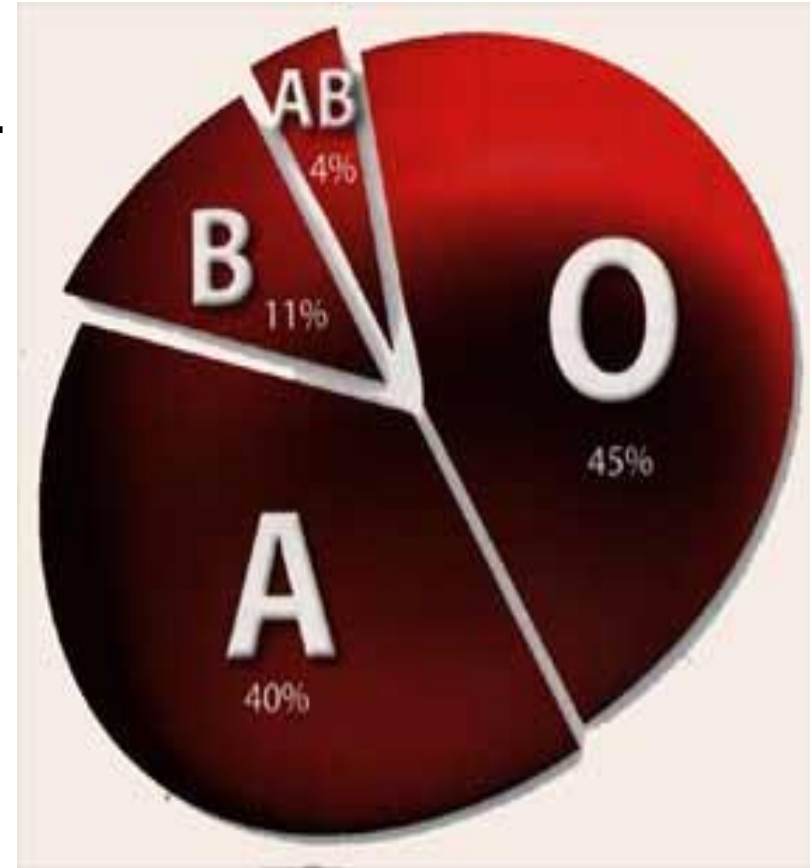
**Rh** positive is the most common **blood** type.

There are four blood types. A, B, AB, and O.

1. A+, A-
2. B+, B-
3. Ab+, Ab-
4. O+, O-

~ All blood has a Rh

~ The Rh determined the blood type.



# WHY DO MOSQUITOES LIKE ME ?

Do you find that mosquitoes and other biting insects choose you, rather than other people ?

Did you ever wonder why ?

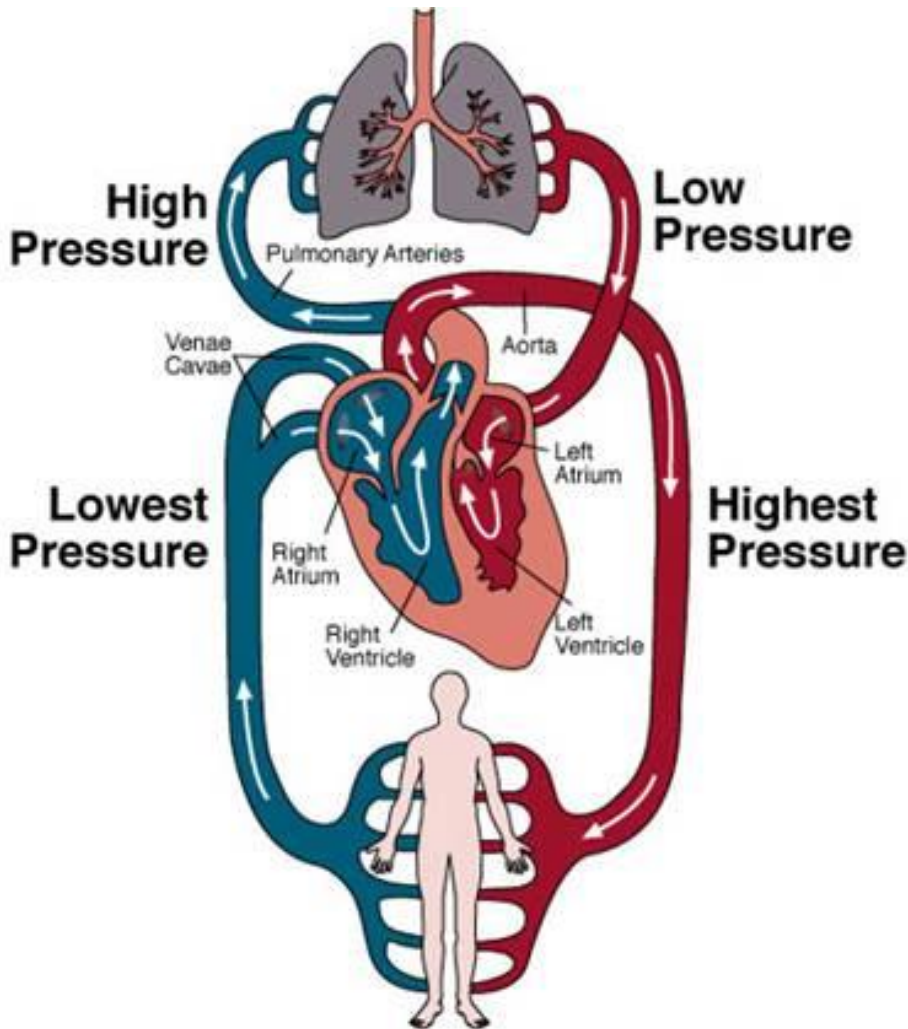
If you have Type O blood, they prefer you twice as much, than others, who have Type A !! People with Type B, fall in the middle of these 2.

An [estimated 20 percent of people](#), it turns out, are especially delicious for mosquitoes, and get bit more often on a consistent basis



# BLOOD PRESSURE

As blood is moved through your body, it exerts pressure against the walls of blood vessels.



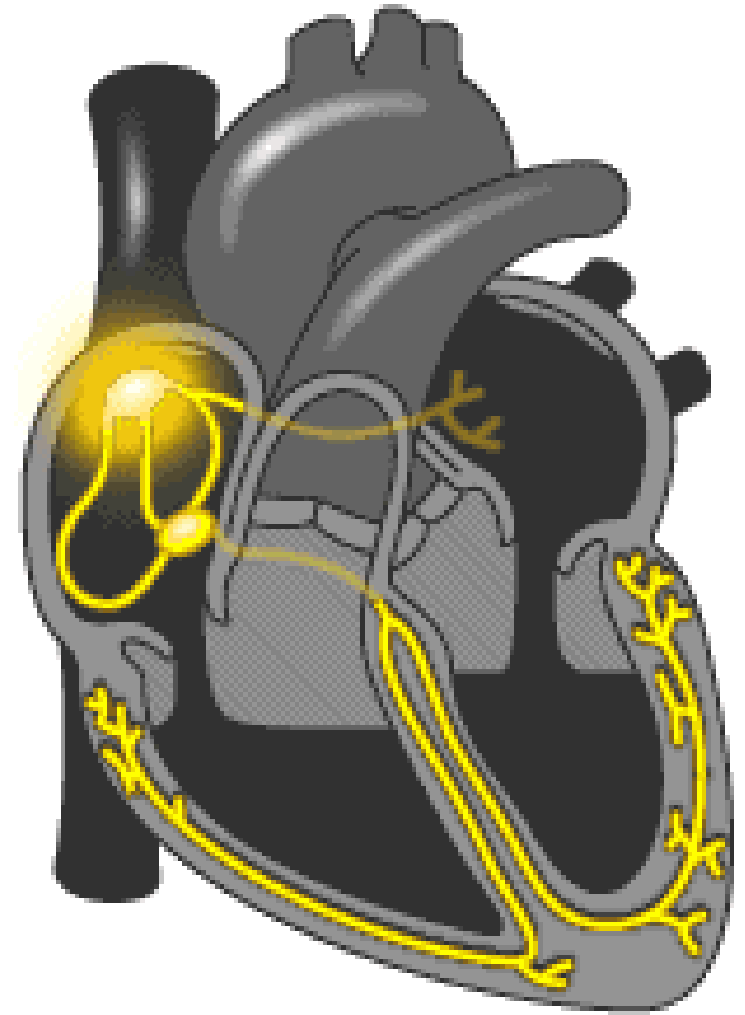
- **Systolic Pressure:** as your heart contracts to push blood into your arteries, your blood pressure is at its highest point.
- **Diastolic Pressure:** As your heart relaxes to refill, blood pressure is at its lowest point.

There is an electrical system inside your heart that controls the rate (speed) and rhythm of your heart. A normal heart rhythm is called **normal sinus rhythm (NSR)**.

When there is a problem with your heart rhythm or rate, it is called **arrhythmia**.

### **The heart's electrical system**

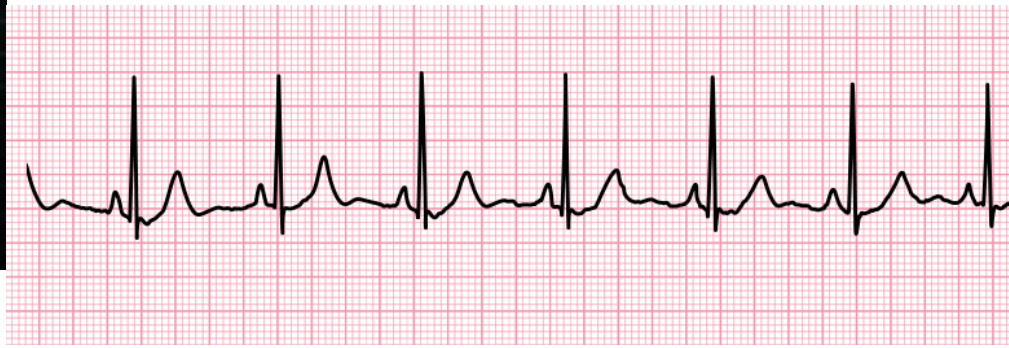
It starts with an electrical signal in the right atrium, at the SA Node (sinoatrial node). The electrical signal then spreads throughout the heart from top to bottom (from atria to ventricles). As one part contracts, the others relax in a sequence.



**WHAT IS AN ECG OR AN EKG?** - An electrocardiogram (ECG or EKG) is a test that checks how your heart is functioning by measuring the electrical activity of the heart.

With each heartbeat, an electrical impulse (or wave) travels through your heart. This wave causes the muscle to squeeze and pump blood from the heart.

An ECG measures and records the electrical activity that passes through the heart. A doctor can determine if this electrical activity is normal or irregular.

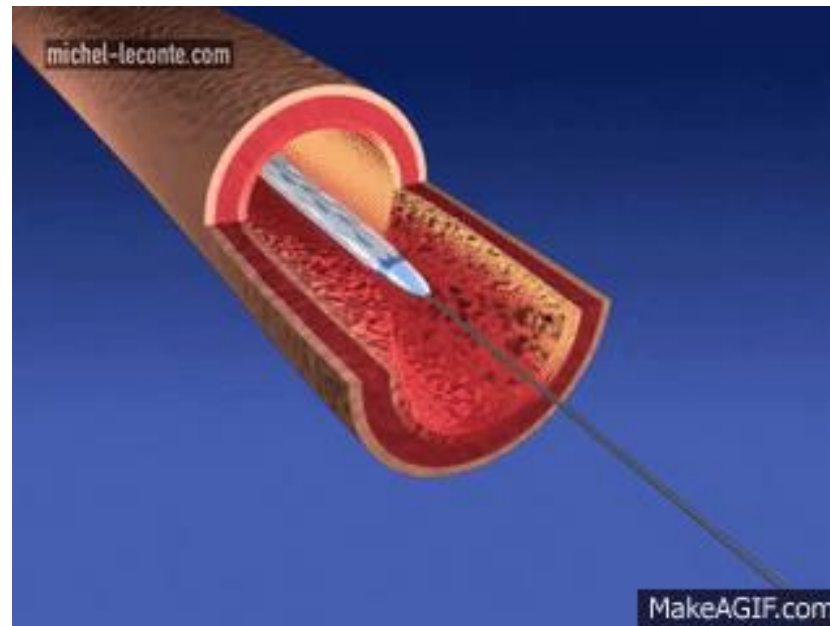


# ANGIOPLASTY, BALLOON ANGIOPLASTY, AND STENTS

Your heart's arteries can become blocked or narrowed from a buildup of cholesterol, cells or other substances (plaque) which can reduce blood flow to your heart and cause chest discomfort.

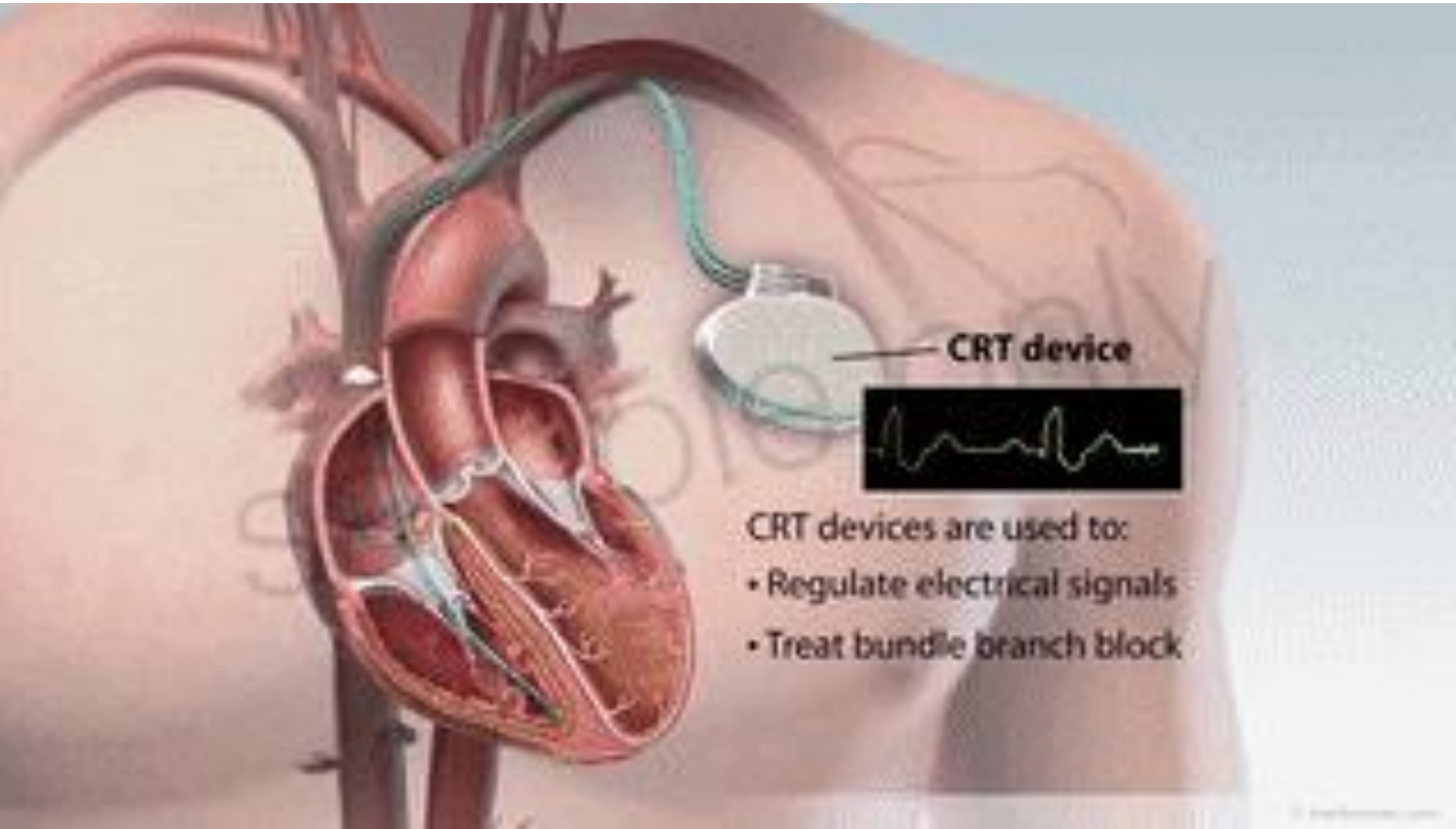
Angioplasty opens blocked arteries and restores normal blood flow to your heart muscle. It is not major surgery.

It is done by threading a catheter (thin tube) through a small puncture in a leg or arm artery to the heart. The blocked artery is opened by inflating a tiny balloon in it.



<https://www.youtube.com/watch?v=p3z9FLYijrQ>

A pacemaker is a battery-operated device placed in the body to produce electrical pulses that cause the heart to beat at a normal rate.



Over the last 60 years, the size of Pacemakers have been reduced a lot

## EVOLUTION OF PACEMAKER TECHNOLOGY



**1958**  
Weight: 73.4g  
Size: 35cc



**1981**  
Weight: 55g  
Size: 25cc



**1995**  
Weight: 14g  
Size: 6cc



**2009**  
Weight: 23g  
Size: 12.8cc



**2013**  
Weight: 2g  
Size: 1cc



## **WORLD'S SMALLEST PACEMAKER**

Medtronic's Micra Pacemaker was approved by the FDA for use in the United States on April 6, 2016.

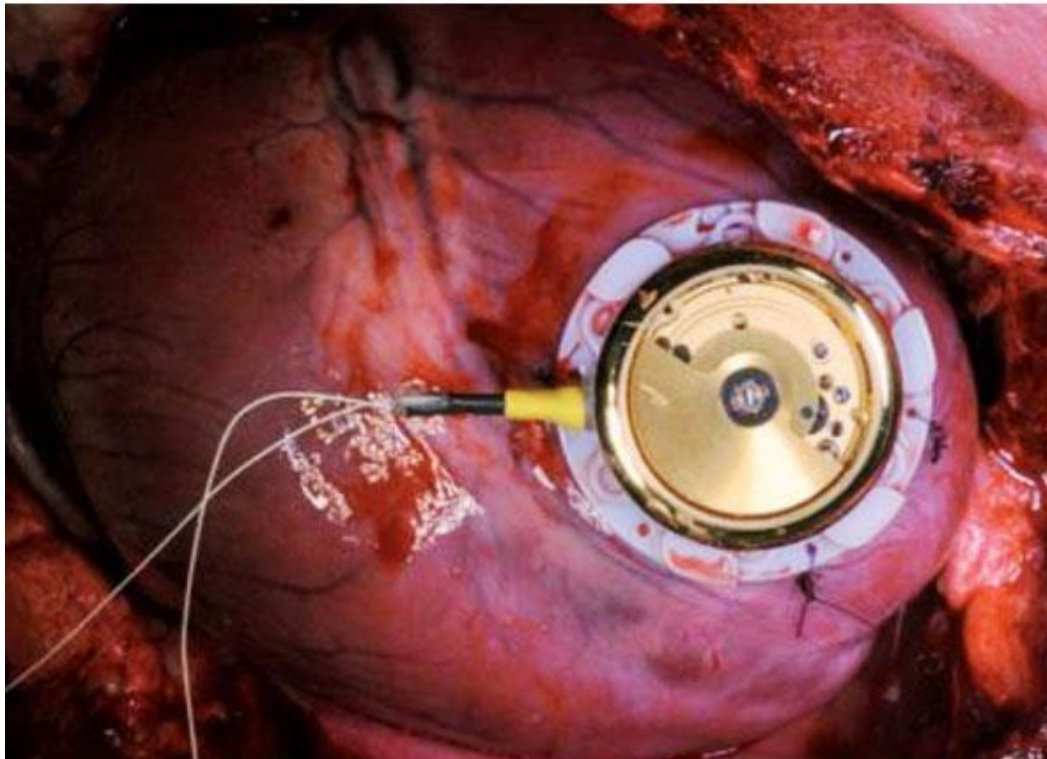
This tiny device is implanted inside the patient's heart and small tines then attach to the heart wall.

It is 93% smaller than conventional pacemakers, and about the size of a large vitamin capsule.



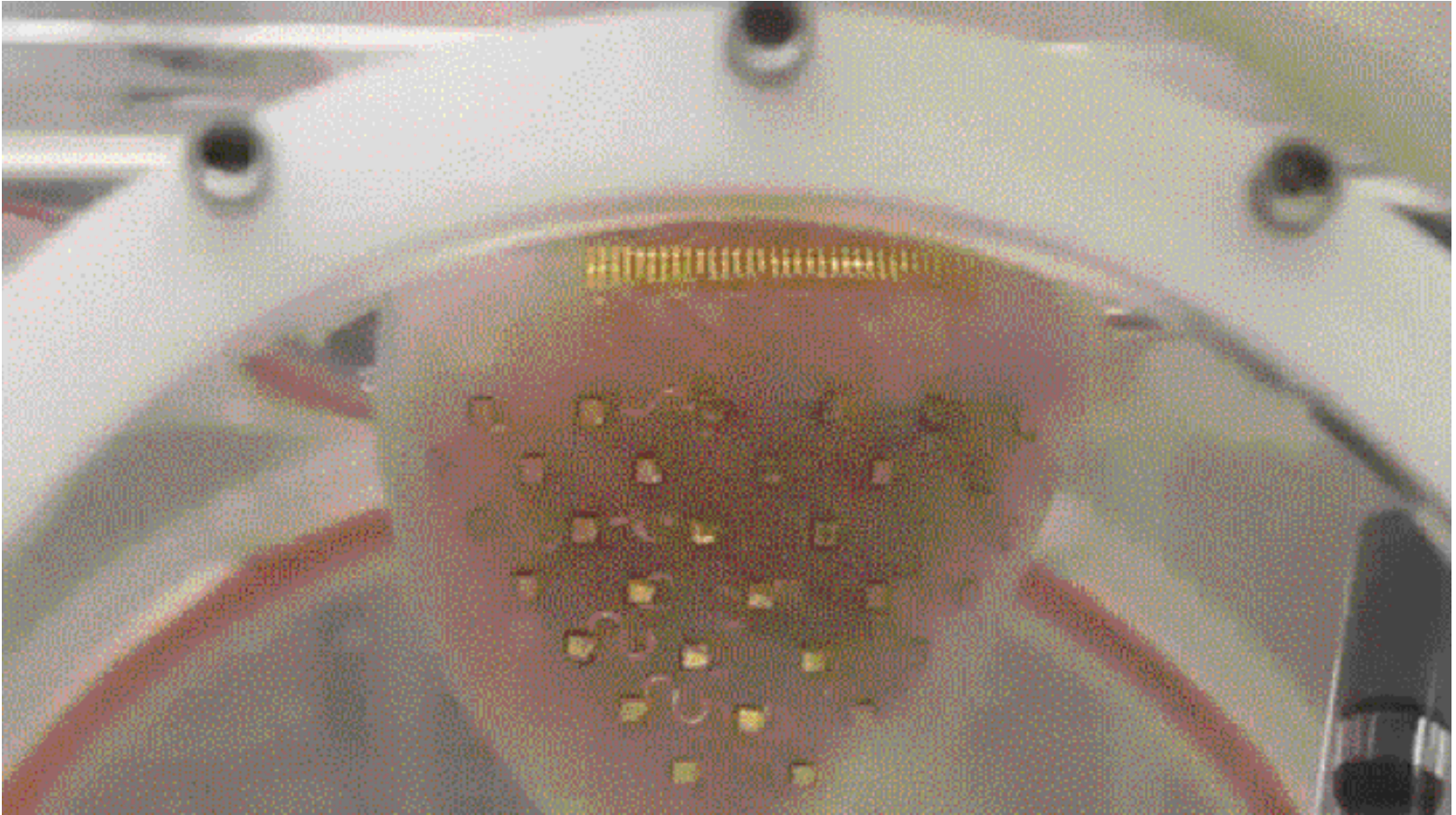
Recent research studies have described the use of energy harvesting to power a pacemaker to eliminate the battery they use, so a future operation isn't needed to replace the unit and battery.

The goal for energy harvesting in this case is to eliminate the need for a battery by generating electricity derived from an external source and possibly from the movement of the heart and surrounding organs !!



This video shows a rabbit heart that has been kept beating outside of the body in a nutrient and oxygen-rich solution.

The new cardiac device -- a thin, stretchable membrane imprinted with a spider-web-like network of sensors and electrodes -- is custom-designed to fit over the heart and contract and expand with it as it beats.

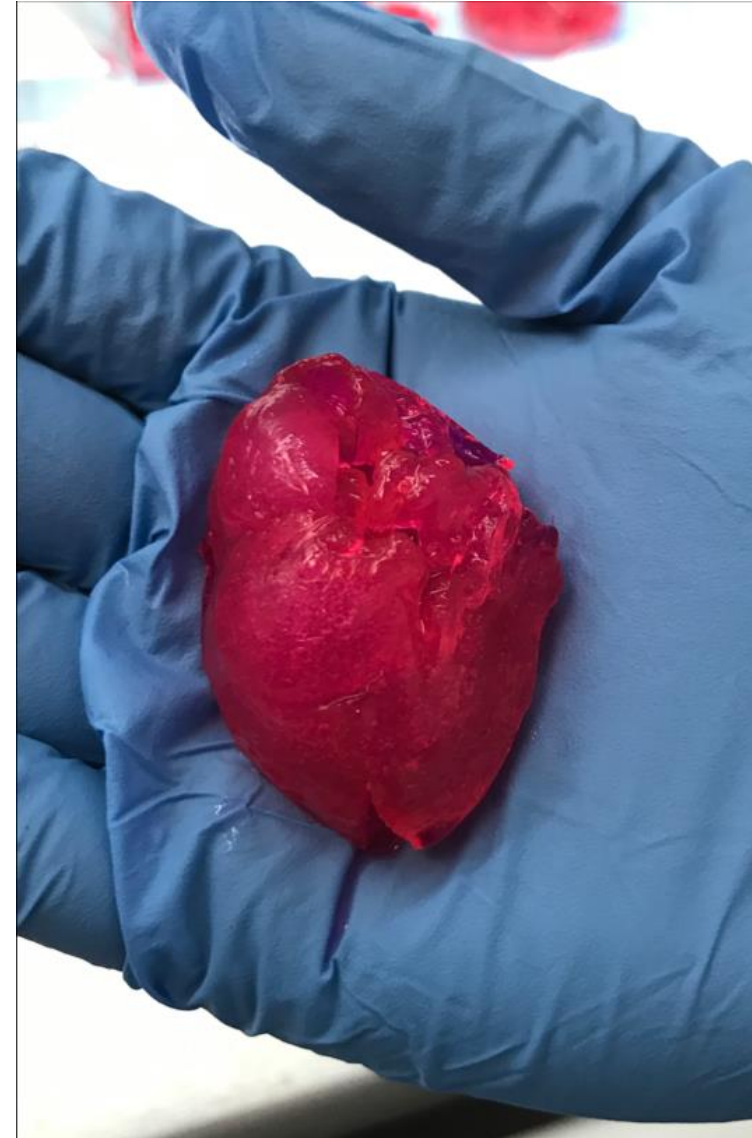


## **BIOLIFE4D MINIATURE HEART**

Chicago-based biotech outfit Biolife4D claims to have 3D bio-printed a miniaturized human heart — chambers, ventricles, and all.

The company used a proprietary bio-ink — the company described it as “similar in properties to gelatin” — that was designed from the ground up to replicate actual human biomaterials.

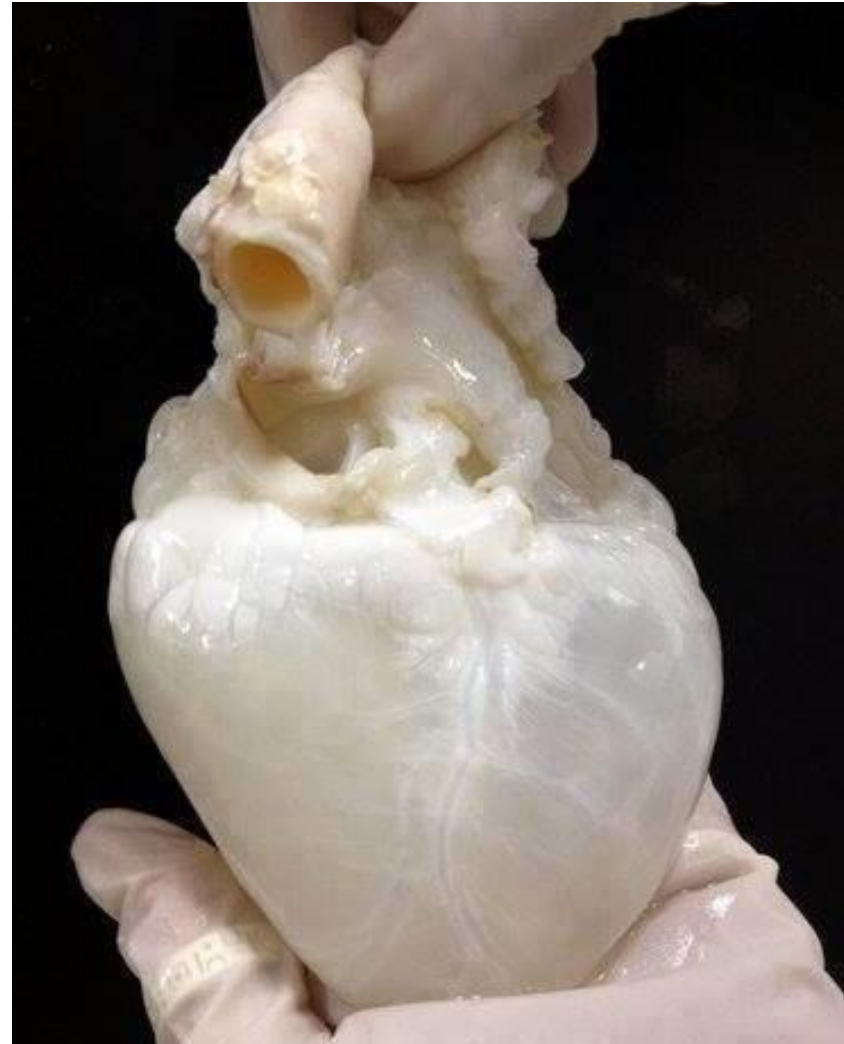
To help with structural integrity during the printing process, Biolife4D printed an additional support scaffold encasing the heart.



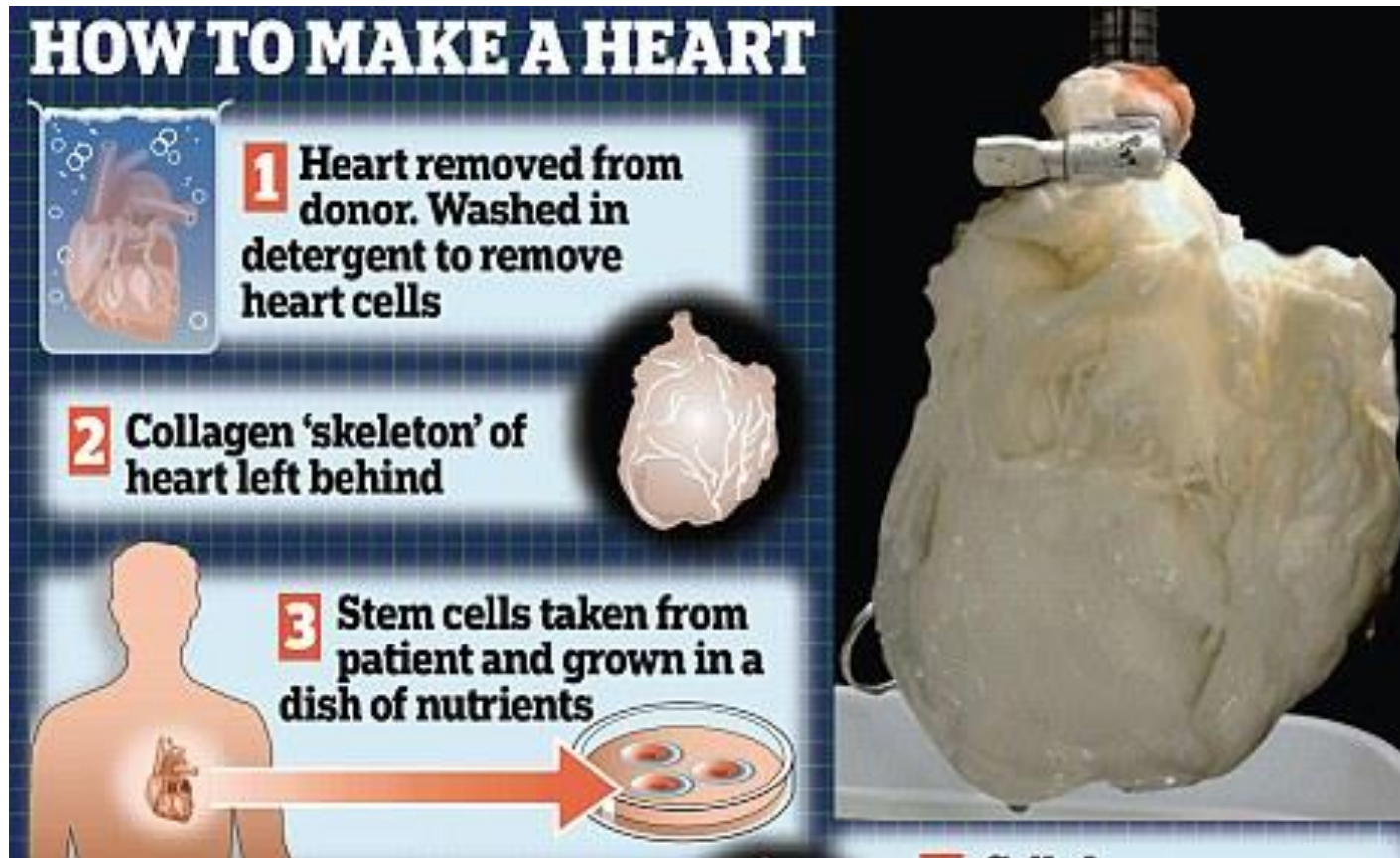
<https://www.youtube.com/watch?v=DcUtKiAsuUQ> (set at .75 speed)

**The problem** - More than 3,200 people are on the waiting list for a heart transplant in the United States.

**The solution** - Take a pig heart, soak it in an ingredient commonly found in shampoo and wash away the cells until you're left with a protein scaffold that is to a heart what two-by-four framing is to a house.



Then inject that ghost heart, as it's called, with hundreds of millions of blood or bone-marrow stem cells from a person who needs a heart transplant, place it in a bioreactor -- a box with artificial lungs and tubes that pump oxygen and blood into it -- and wait as the ghost heart begins to mature into a new, beating human heart.



It's interesting that there are other colors of blood, than our own red. The colors shown below are the real colors of various other creatures.

## THE DIFFERENT COLOURS OF BLOOD

---



*Red*

HUMANS AND THE MAJORITY OF  
OTHER VERTEBRATES

HAEMOGLOBIN



*Blue*

SPIDERS, CRUSTACEANS, SOME  
MOLLUSCS, OCTOPUSES & SQUID

HAEMOCYANIN



*Green*

SOME SEGMENTED WORMS, SOME  
LEECHES, & SOME MARINE WORMS

CHLOROCRUORIN



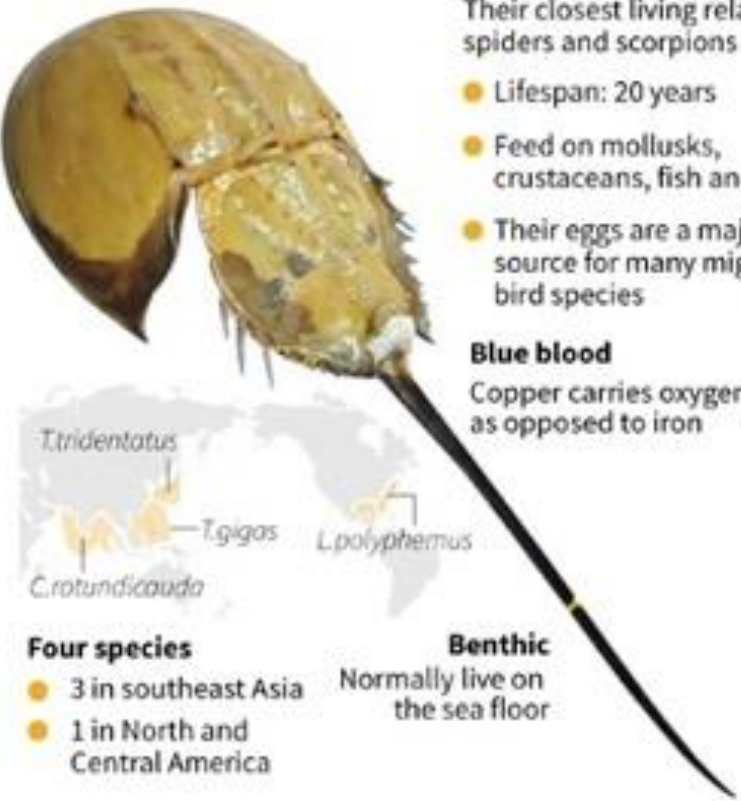
*Violet*

MARINE WORMS INCLUDING PEANUT  
WORMS & BRACHIOPODS

HAEMERYTHRIN

# The horseshoe crab

Recognisable ancestors date back 450 million years



### Not a crab!

Their closest living relatives are spiders and scorpions

- Lifespan: 20 years
- Feed on mollusks, crustaceans, fish and algae
- Their eggs are a major food source for many migrating bird species

### Blue blood

Copper carries oxygen, as opposed to iron

### Benthic

Normally live on the sea floor

### Four species

- 3 in southeast Asia
- 1 in North and Central America

### Unusual anatomy

The "head" section contains much of nervous and digestive systems

Two compound eyes at side of head



Book gills for breathing in water



### A medical wonder




- The blood of the Atlantic species contains a sensitive coagulant that can detect tiny amounts of bacteria
- Used since the 1970s to test sterility of medical equipment and intravenous drugs
- 600,000 crabs a year harvested for medical supplies
- 30% of blood taken, and then crab returned to sea
- Of those returned, 10 - 30% die
- One litre of the blood is worth \$15,000



# COOL FACTS ABOUT YOUR CIRCULATORY SYSTEM

- ❖ The body of an adult contains over 60,000 miles of blood vessels!
- ❖ An adult's heart pumps nearly 4,000 gallons of blood each day!
- ❖ **In one day your heart beats 100,000 times, which comes out to about 30 million times a year which is at least 2.8 *billion* times during the average life span – and with resting between beats !**
- ❖ A "heartbeat" is really the sound of the valves in the heart closing as they push blood through its chambers.
- ❖ Women's hearts beat faster than men's.
- ❖ A single drop of Blood contains 250 million red blood cells and 275,000 white blood cells !

The background of the slide is a detailed, artistic rendering of a blood vessel. The vessel's interior is a dark, reddish-brown color with a textured, almost fibrous appearance. Several large, bright red, biconcave disc-shaped red blood cells are shown in various stages of movement through the vessel. Some are in the foreground, appearing larger and more detailed, while others are further away, creating a sense of depth. The lighting is dramatic, with highlights on the edges of the red blood cells and a darker, shadowed center of the vessel.

It takes about 20 seconds for a red blood cell to circle the whole body.

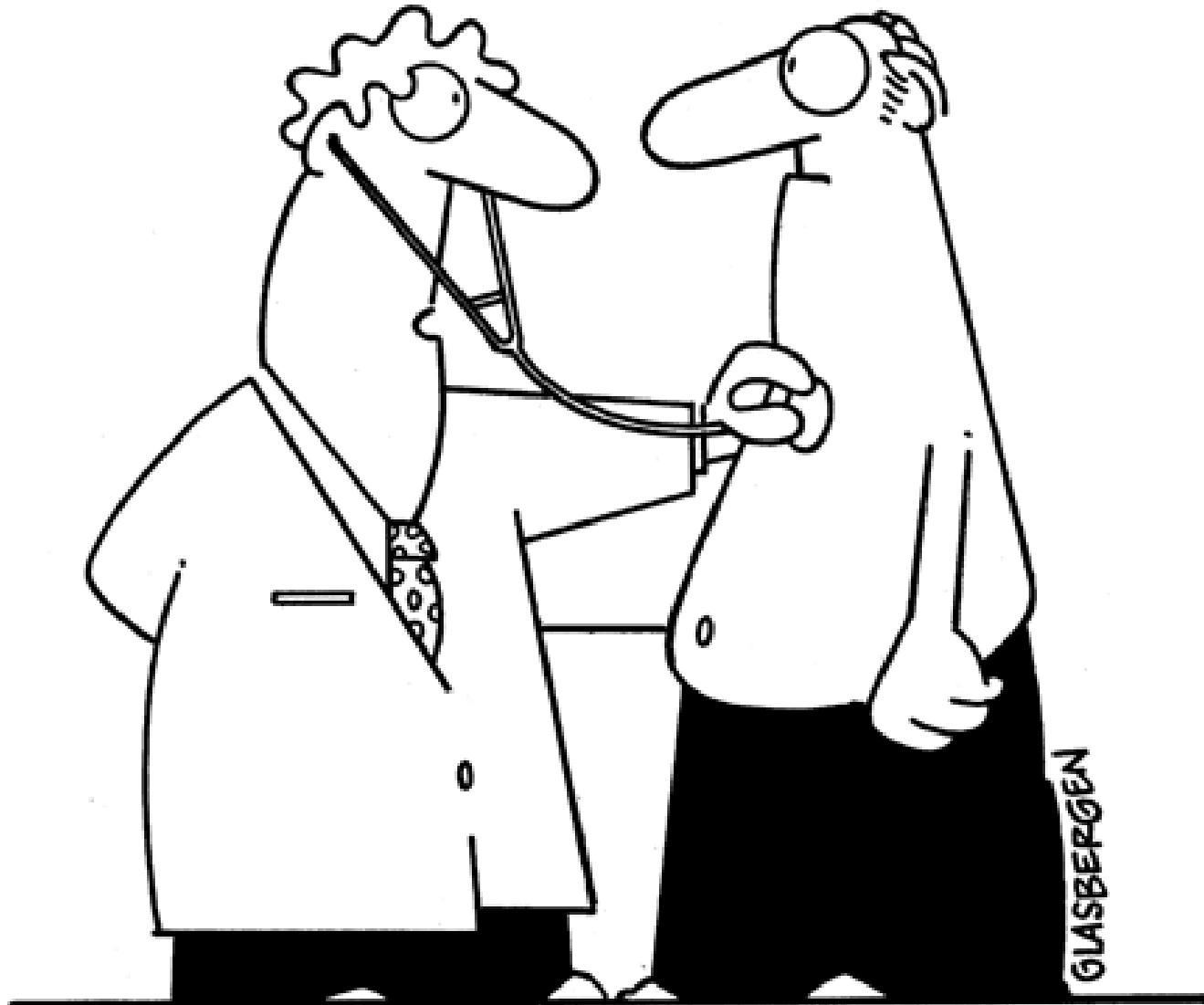
In ten years, a cell will have travelled over 59,654 miles – equivalent to 2.4 times the distance around the earth!

Human lips have a reddish color because of the great concentration of tiny blood capillaries just below the skin.

The blood in these capillaries is normally highly oxygenated and therefore quite red. This explain why the lips appear pale when a person is anemic.

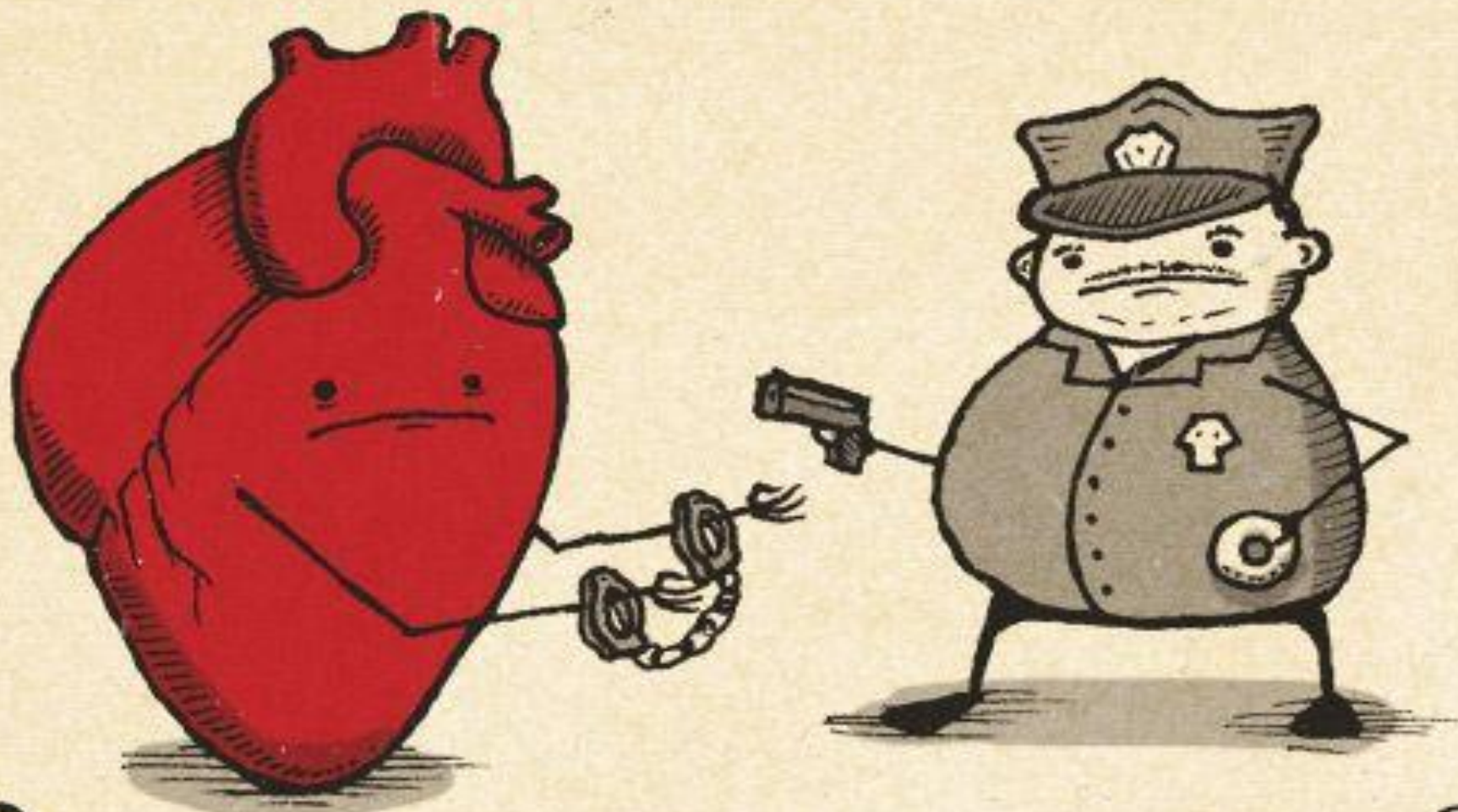


AND NOW SOME HEART HUMOR...



**"I hear reggae rhythms, disco drums, thumping hip-hop,  
toe-tapping western swing, and 80's techno beats.  
I think your pacemaker is stuck on 'shuffle'!"**

# Cardiac Arrest



Angina is chest pain or discomfort caused when your heart muscle doesn't get enough oxygen-rich blood.

Angina is chest pain or discomfort caused when your heart muscle doesn't get enough oxygen-rich blood.





*"And now, for the winner of the echocardiogrammy!"*





© TUCKER

"Yes! That was very loud Mr. Trainer,  
but I said I wanted to hear your *HEART!*"

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[https://en.wikipedia.org/wiki/Circulatory\\_system](https://en.wikipedia.org/wiki/Circulatory_system)

THE END