INFOGRAPHHUB SERIES · 8 PARTS · AGES 11–16

# The Human Heart

Eight infographics on the pump that keeps you alive: its parts, the route of blood, the numbers, the history and the myths.

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Each part is one printable infographic. Work through them in order, or use the part you need. The quiz answers are printed upside down at the foot of the quiz. Sources for every part are listed on its page at infographhub.com.

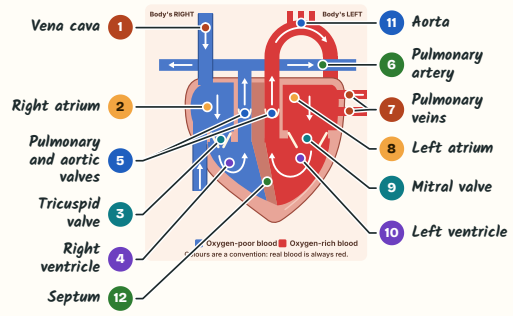
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THE HUMAN HEART · PART 1 OF 8 · AGES 11–16

# The Human Heart Explained

A muscular pump about the size of your fist, with four chambers, four one-way valves and the big blood vessels that link it to your lungs and body.




### 1 Vena cava

Two large veins, the superior and inferior vena cava, bring oxygen-poor blood back from the body into the right atrium.

### 2 Right atrium

Upper right chamber. It collects oxygen-poor blood from the body and passes it down into the right ventricle.

### 3 Tricuspid valve

One-way valve between the right atrium and right ventricle. Its flaps shut when the ventricle squeezes, so blood cannot flow back.

### 4 Right ventricle

Lower right chamber. It pumps oxygen-poor blood out through the pulmonary artery to the lungs.

### 5 Pulmonary and aortic valves

Valves at the exits of the two ventricles. The pulmonary valve opens into the pulmonary artery and the aortic valve into the aorta.

### 6 Pulmonary artery

Splits in two to carry blood from the right ventricle to both lungs. Unusually for an artery, it carries oxygen-poor blood.

### 7 Pulmonary veins

Four veins that bring oxygen-rich blood back from the lungs into the left atrium. Unusually for veins, their blood is rich in oxygen.

### 8 Left atrium

Upper left chamber. It receives oxygen-rich blood from the lungs and passes it down into the left ventricle.

### 9 Mitral valve

One-way valve between the left atrium and left ventricle. It has two flaps, so it is also called the bicuspid valve.

### 10 Left ventricle

The largest and strongest chamber. Its thick muscular wall pumps oxygen-rich blood into the aorta and around the whole body.

### 11 Aorta

The body's main artery. It arches over the top of the heart and carries oxygen-rich blood from the left ventricle to the body.

### 12 Septum

A wall of muscle dividing the right side of the heart from the left, so oxygen-poor and oxygen-rich blood never mix.

### How to read a heart diagram

Heart diagrams are drawn as if you are facing the person, so the heart's right side appears on your left. Blue and red are only a convention for oxygen-poor and oxygen-rich blood: real blood is always red.

NEXT IN THE SERIES

**2. How Blood Flows Through the Heart**

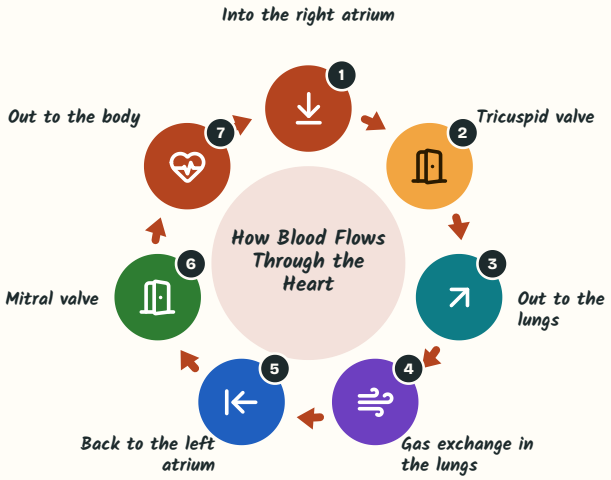


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THE HUMAN HEART PART 2 OF 8 · AGES 11–16

# How Blood Flows Through the Heart

Seven steps that take one drop of blood from the body to the lungs, back to the heart and out again.




## 1 Into the right atrium

Oxygen-poor blood from the body flows in through the superior and inferior vena cava and fills the right atrium.

## 2 Tricuspid valve

The right atrium squeezes and pushes blood through the open tricuspid valve into the right ventricle.

## 3 Out to the lungs

The right ventricle contracts. The tricuspid valve shuts and blood is forced through the pulmonary valve into the pulmonary artery.

## 4 Gas exchange in the lungs

In tiny capillaries around the air sacs, the blood gives up carbon dioxide and picks up oxygen. It is now oxygen-rich.

## 5 Back to the left atrium

Oxygen-rich blood returns from the lungs through the pulmonary veins and fills the left atrium.

## 6 Mitral valve

The left atrium squeezes and pushes blood through the open mitral valve into the left ventricle.

## 7 Out to the body

The thick left ventricle contracts hard. The mitral valve shuts and blood surges through the aortic valve into the aorta, then on round the body and back to the vena cava.

### One beat, two journeys

The two sides work at the same time: both atria contract together, then both ventricles. So every beat sends blood to the lungs (steps 1–3) and to the body (steps 5–7) at once.

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**3. The Heart by the Numbers**



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THE HUMAN HEART · PART 3 OF 8 · AGES 11–16

# The Heart by the Numbers

How often your heart beats, how much blood it moves and how big it really is, with the working shown.

## 100,000

**times your heart beats in an average day**

At about 70 beats a minute: 70 × 60 × 24 ≈ 100,800. Over a long life that is more than 3.5 billion beats.

## 60–100

**beats per minute: a normal resting heart rate from age 10**

Younger children have faster rates, such as 70–110 at ages 7 to 9. Very fit athletes can rest at 40–60.

## 70 mL

**of blood pushed out by each ventricle in one beat at rest**

This is the stroke volume. The normal resting range is about 55–100 mL.

## ~5 litres

**of blood pumped by each ventricle every minute at rest**

The cardiac output: 70 mL × 75 beats ≈ 5.25 litres. The normal range is about 4–8 litres a minute.

## 7,500 litres

**of blood pumped through the body in one day**

5.25 litres × 1,440 minutes ≈ 7,560 litres. Yet an adult body holds only about 5 litres of blood.

## 12 cm

**long: an adult heart is about the size of a fist**

Roughly 12 cm long, 8 cm wide and 6 cm thick.

## ~300 g

**is roughly what an adult heart weighs**

Typically 250–300 g in women and 300–350 g in men, in line with average body size.

## 96,500 km

**of blood vessels in an adult, if laid end to end**

More than twice round the Equator, which is about 40,075 km long.

### When you exercise

In a healthy young person, heart rate can rise to about 150 beats a minute and each beat can push out about 130 mL. That lifts the output to about 19.5 litres a minute: 4 to 5 times the resting figure.

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*4. Arteries, Veins and Capillaries*


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THE HUMAN HEART · PART 4 OF 8 · AGES 11–16

# Arteries, Veins and Capillaries

Arteries take blood out, veins bring it home, and the tiny capillaries in between do the real work of exchange.

| | Arteries | Veins |
|---|---|---|
| **DIRECTION** | Carry blood away from the heart | Carry blood back to the heart |
| **OXYGEN** | Oxygen-rich, except the pulmonary artery, which takes oxygen-poor blood to the lungs | Oxygen-poor, except the pulmonary veins, which bring oxygen-rich blood from the lungs |
| **PRESSURE** | High: blood surges in with every beat of the ventricles | Low: the pressure has dropped after the capillaries |
| **WALLS** | Thick, with layers of muscle and elastic fibres that stretch and recoil | Thinner, with less muscle and elastic tissue |
| **LUMEN (SPACE INSIDE)** | Narrow compared with the thick wall | Wide, so blood flows back easily at low pressure |
| **VALVES** | None along their length | Many have valves, especially in the limbs, to stop blood flowing backwards |

### Capillaries: the link between them

Arteries branch into capillaries only 5–10 micrometres wide, with walls one cell thick. Here oxygen and glucose pass out to the cells and carbon dioxide passes in. Capillaries then join up to form veins.

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*5. Heart Key Terms and Definitions*


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THE HUMAN HEART · PART 5 OF 8 · AGES 11–16

# Heart Key Terms

The words you need to describe the heart precisely, each with a short definition.

## Parts of the heart

| | |
|---|---|
| Atrium (plural: atria) | One of the two upper chambers. The atria receive blood from veins and pass it down to the ventricles. |
| Ventricle | One of the two lower chambers. Their thick walls contract to pump blood out of the heart into arteries. |
| Septum | The wall of muscle that separates the right and left sides of the heart, keeping oxygen-poor and oxygen-rich blood apart. |
| Myocardium | The thick middle layer of the heart wall, made of cardiac muscle, which contracts to pump blood. |
| Coronary arteries | Arteries that branch off the aorta and run over the surface of the heart, supplying the heart muscle itself with oxygen. |

## Valves

| | |
|---|---|
| Atrioventricular valves | The valves between each atrium and ventricle: the tricuspid (three flaps, right side) and the mitral or bicuspid (two flaps, left side). |
| Semilunar valves | The pulmonary and aortic valves at the exits of the ventricles. They stop blood flowing back from the arteries into the heart. |
| Chordae tendineae | Strong cords that anchor the flaps of the atrioventricular valves, so the flaps cannot be pushed back up into the atria. |

## Circulation

| | |
|---|---|
| Double circulation | A system of two loops in which blood passes through the heart twice on each full circuit: once to the lungs, once to the body. |
| Pulmonary circulation | The loop from the right ventricle to the lungs, where blood gains oxygen, and back to the left atrium. |
| Systemic circulation | The loop from the left ventricle round the rest of the body and back to the right atrium. |
| Oxygenated / deoxygenated | Oxygen-rich and oxygen-poor blood. Diagrams colour them red and blue, but real blood is always red. |

## The heartbeat

| | |
|---|---|
| Sinoatrial (SA) node | The heart's natural pacemaker: a group of cells in the wall of the right atrium that starts each beat with an electrical signal. |
| Atrioventricular (AV) node | Passes the signal from the atria to the ventricles after a short delay, so the ventricles can finish filling first. |
| Systole and diastole | Systole is the contracting, pumping phase of a heartbeat. Diastole is the relaxing phase, when the chambers fill with blood. |
| Stroke volume and cardiac output | Stroke volume: blood pumped by one ventricle in a beat. Cardiac output: blood pumped per minute = stroke volume × heart rate. |
| ECG (electrocardiogram) | A recording of the heart's electrical signals made with sensors on the skin. Its main waves are labelled P, QRS and T. |

### Memory hook

Arteries carry blood Away from the heart: both start with A. The rule is about direction, not oxygen, which is why the pulmonary artery can carry oxygen-poor blood.

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*6. Discovering the Heart: A Timeline*

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THE HUMAN HEART · PART 6 OF 8 · AGES 11–16

# Discovering the Heart

More than 1,800 years of questions, mistakes and experiments that revealed what the heart really does.

**2nd century AD — Galen's model**
The Greek physician Galen teaches that the liver makes blood, the body uses it up, and some blood seeps through invisible pores in the septum.

**13th century — Ibn al-Nafis traces the lung circuit**
Working in Cairo, Ibn al-Nafis writes that the septum has no pores: blood goes from the right side of the heart through the lungs to the left.

**1555 — Vesalius doubts Galen**
In a new edition of his anatomy book, Andreas Vesalius writes that he cannot see how any blood could pass through the septum.

**1628 — Harvey proves circulation**
William Harvey publishes De Motu Cordis. His experiments and sums show the heart pumps the same blood round the body again and again.

**1661 — Malpighi sees capillaries**
Looking at a frog's lung through a microscope, Marcello Malpighi sees tiny vessels joining arteries to veins: the missing link in Harvey's circuit.

**1887 — First human ECG**
Augustus Waller records the heart's electrical activity from the surface of a person's body for the first time.

**1903 — Einthoven's string galvanometer**
Willem Einthoven publishes a far more sensitive ECG recorder, the forerunner of today's machines. He wins the 1924 Nobel Prize for this work.

**1967 — First heart transplant**
On 3 December, Christiaan Barnard's team in Cape Town, South Africa, transplants a human heart. The patient, Louis Washkansky, lives for 18 days.

### Why it took so long

Blood moves through capillaries far too small to see with the naked eye, so the full circuit stayed hidden until experiments, careful arithmetic and the microscope revealed it.

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*7. Heart Myths and the Real Science*


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THE HUMAN HEART · PART 7 OF 8 · AGES 11–16

# Heart Myths

Eight things many people believe about the heart, and what scientists have found instead.

**MYTH** **Your heart is on the left side of your chest.** 1

**FACT** It sits near the middle of your chest, behind the breastbone, tilted slightly left. Its lower tip points left, so you feel the beat just left of centre.

**MYTH** **The blood in your veins is blue.** 2

**FACT** Blood is always red: bright red with lots of oxygen, darker red with less. Veins only look bluish because of the way light passes through your skin.

**MYTH** **Your heart stops for a moment when you sneeze.** 3

**FACT** It keeps beating. A sneeze changes the pressure in your chest and can briefly alter the rhythm, but heart monitors show no real pause.

**MYTH** **A real heart is shaped like a love heart.** 4

**FACT** It is shaped more like a pinecone: broad at the top, where the big blood vessels attach, and narrowing to a rounded tip. It is about the size of a fist.

**MYTH** **The 'lub-dub' of a heartbeat is the sound of the muscle squeezing.** 5

**FACT** It is valves closing. 'Lub' is the tricuspid and mitral valves shutting as the ventricles contract; 'dub' is the aortic and pulmonary valves shutting.

**MYTH** **Your brain has to send a signal to start every heartbeat.** 6

**FACT** The heart's own pacemaker, the SA node, starts each beat. On its own it would fire about 80–100 times a minute; nerves and hormones just speed it up or slow it down.

**MYTH** **The heart makes your blood.** 7

**FACT** The heart only pumps blood. Red and white blood cells and platelets are made in the red bone marrow inside bones such as the hips, breastbone and spine.

**MYTH** **The left side of the heart pumps more blood than the right.** 8

**FACT** Both ventricles pump the same amount with each beat. The left wall is thicker because it must push blood all round the body, which needs much more pressure.

### Conventions are not reality

Blue veins in diagrams, the love-heart symbol and 'the heart is on the left' are all handy shortcuts. Use them to remember things, but describe the real heart in an answer.

NEXT IN THE SERIES
*8. Human Heart Quiz: Test Yourself*


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THE HUMAN HEART · PART 8 OF 8 · AGES 11–16

# Human Heart Quiz

Ten questions on the whole series. Answer them all, then turn the page round to check.

**1** Which chamber pumps oxygen-poor blood to the lungs?

- A Right atrium
- B Right ventricle
- C Left atrium
- D Left ventricle

**2** Which valve lies between the left atrium and the left ventricle?

- A Tricuspid valve
- B Pulmonary valve
- C Mitral valve
- D Aortic valve

**3** Which blood vessels bring oxygen-rich blood from the lungs into the heart?

- A Vena cava
- B Aorta
- C Pulmonary artery
- D Pulmonary veins

**4** Roughly how many times does a heart beat in one day?

- A About 1,000
- B About 10,000
- C About 100,000
- D About 1,000,000

**5** Which structure starts each heartbeat?

- A The AV node
- B The SA node
- C The septum
- D The brain

**6** Why does the left ventricle have a thicker wall than the right?

- A It pumps more blood per beat
- B It pushes blood all round the body
- C It receives blood from the body
- D It contains the pacemaker

**7** Which blood vessels have walls only one cell thick?

- A Arteries
- B Veins
- C Capillaries
- D The aorta

**8** Who published proof that blood circulates round the body, in 1628?

- A Galen
- B Ibn al-Nafis
- C William Harvey
- D Christiaan Barnard

**9** What does 'double circulation' mean? Name both loops.

**10** Diagrams show oxygen-poor blood in blue. What colour is it really, and why is it drawn blue?

**ANSWERS**

**1.** B: Right ventricle
**2.** C: Mitral (bicuspid) valve
**3.** D: Pulmonary veins
**4.** C: About 100,000 (70 × 60 × 24 ≈ 100,800)
**5.** B: The SA node, the heart's natural pacemaker
**6.** B: It must push blood all round the body (both ventricles pump the same amount)
**7.** C: Capillaries
**8.** C: William Harvey
**9.** Blood passes through the heart twice per circuit: the pulmonary loop (heart–lungs) and the systemic loop (heart–body)
**10.** Dark red: all blood is red. Blue is only a convention to tell oxygen-poor from oxygen-rich blood

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