EXTERNAL CONFIGURATION OF THE HEART

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PLAN:

I. INTRODUCTION

II. GENERAL OVERVIEW

III. EXTERNAL CONFIGURATION OF THE HEART

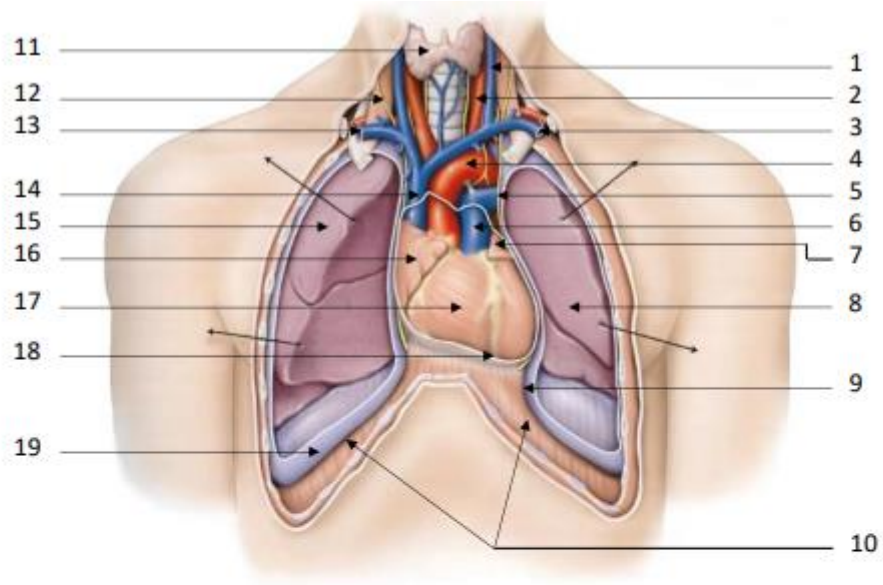
IV. MEASUREMENTS AND CARDIAC SHAPES

V. TOPOGRAPHIC RELATIONS OF THE HEART

VI. CONCLUSION

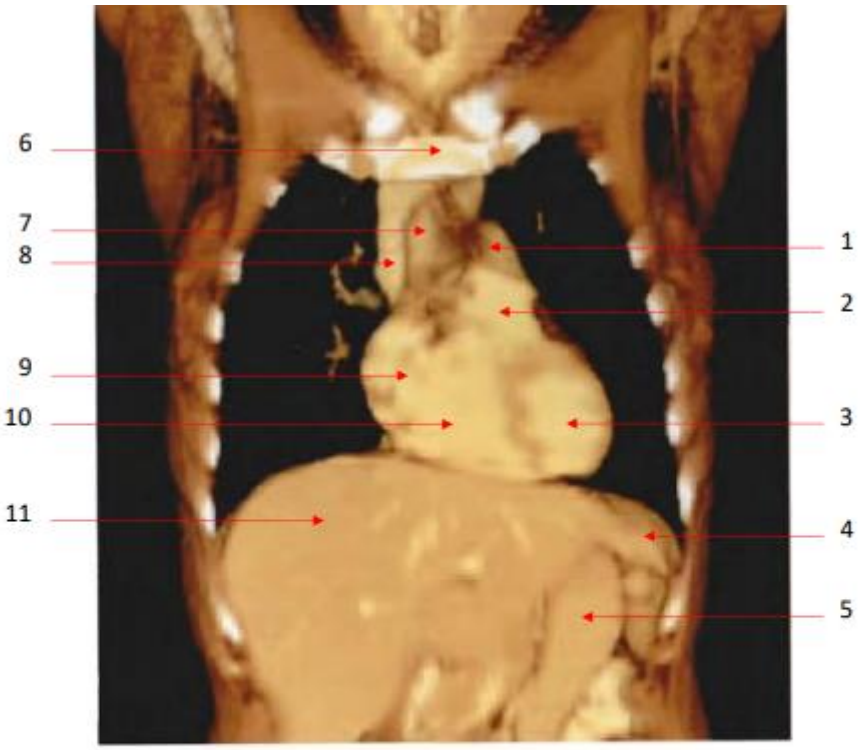
I – INTRODUCTION:

- The heart is the central hub of the circulatory system, directing blood flow through both the systemic and pulmonary circuits.
- It is a fibro-muscular organ encased in a protective membrane called the pericardium.



1- Left internal jugular vein
2- Left common carotid artery
3- Left brachiocephalic vein
4- Aortic arch
5- Left phrenic nerve
6- Pulmonary trunk
7- Left auricle
8- Left phrenic nerve
9- Left pleura
10- Diaphragm
11- Thyroid gland
12- Right phrenic nerve
13- Right brachiocephalic vein
14- Superior vena cava
15- Right lung
16- Right auricle
17- Heart
18- Pericardium
19- Right pleura

Heart in situ, thorax resected (anterior view)



1- Pulmonary trunk
2- Left atrium
3- Left ventricle
4- Spleen
5- Stomach
6- Manubrium sterni
7- Ascending aorta
8- Superior vena cava
9- Right atrium
10- Right ventricle
11- Liver

Heart in situ: coronal 3D CT scan (image by Dr Th. Diesce)

***Note**: In industrialised countries, heart disease is the leading cause of death, accounting for 32.5% of cases. The heart is the focus of many surgical treatments, particularly the implantation of valve prostheses and transplants.*

II – GENERAL OVERVIEW:

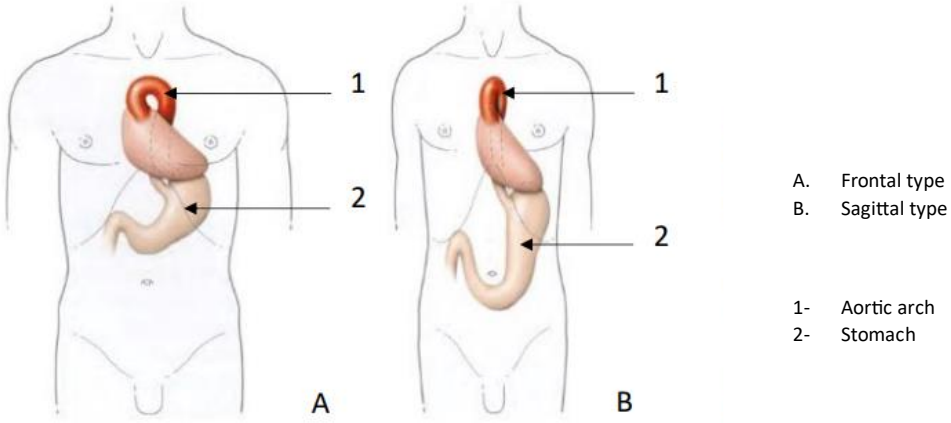
1. Situation:

- The heart is located in the thoracic cavity and occupies the **anterior mediastinum**, which is the area between the two **pleuropulmonary cavities**.
- It is situated between the two **diaphragmatic domes**.

Note: ***Extrapulmonary cardiac ectopia*** *is lethal.*

2. Shape – orientation:

- It has a pyramidal shape, with a **posterior base** and an **antero-left apex**.
- Its long axis, extending from the base to the apex, is oblique forward, to the left, and slightly downward.



Appearance of the heart and aortic arch according to morphological type

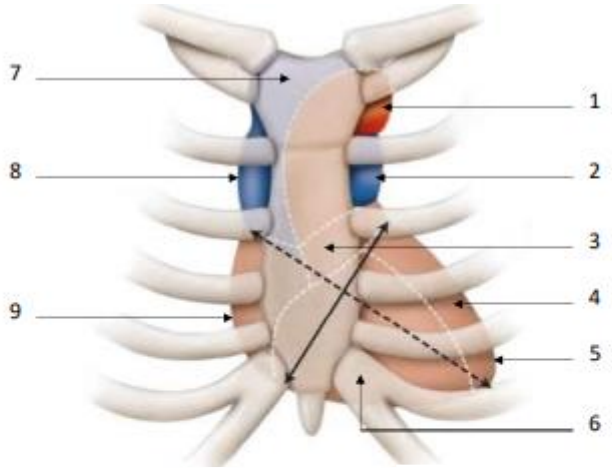
- There are some **variations** :
  - Individuals with a frontal type usually have a **transversal heart**, meaning it has a **horizontal long axis**.
  - Individuals with a sagittal type usually have a **vertical heart**, meaning it has a **vertical long axis**.

3. Color and consistency :

- It is **reddish** and dotted with **fatty deposits** on its surface.
- Its consistency is soft and **depressible** in the atria, while it is firm and **resistant** in the ventricles; the thickness of the **right ventricular wall** is **5 to 6 mm**, and that of the **left ventricle** is **10 to 15 mm**.

4. Measurements :

The evaluation of heart size, important in clinical practice, relies on **radiology** and **echocardiography**.



1- Aorta
2- Pulmonary trunk
3- Left auricle
4- Apex
5- Right ventricle
6- Left ventricle
7- Right and left brachiocephalic veins
8- Superior vena cava
9- Right atrium

Precordial region (surface anatomy of the heart and great vessels)

a. Cardiac diameters :

These help assess **cardiac volume**. In practice, their measurement is done on the **radiological heart shadow**.

- The **long axis** of the heart measures approximately **12 cm**.
- The **largest transversal diameter**, perpendicular to the long axis, is **9 cm**.

b. Weight :

It is on average **300 grams** in men and **250 grams** in women.

Note: *The heart functions as a true* ***suction and expulsion pump*** *for blood, with rhythmic contractions ranging from* ***64 to 74 beats per minute****.*

III – EXTERNAL CONFIGURATION OF THE HEART:

Due to its shape, the heart has **three surfaces**, **three borders**, a **base**, and an **apex**.

1. Surfaces of the heart:

– The three faces of the heart are:
  - the **anterior** or **sternocostal** surface,
  - the **inferior** or **diaphragmatic** surface,
  - and the **left lateral** surface.

– Each of these surfaces is divided by the **auriculoventricular sulcus** into two segments: one **anterior** or **ventricular**, and the other **posterior** or **auricular**.

a. Anterior surface of the heart :

– The **anterior** or **sternocostal** surface of the heart faces forward and to the right.

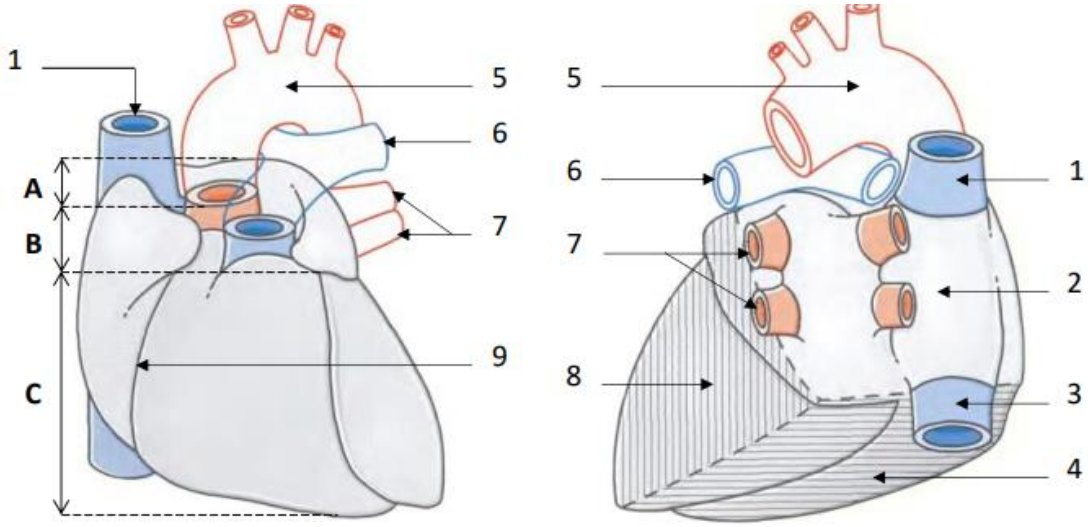
– The **ventricular segment** has two zones: one **posterior** or **arterial**, and the other **anterior**.

  - The **arterial zone** is entirely occupied by the **aortic orifice** and the **pulmonary artery orifice**.
  - The **anterior zone** is slightly convex and divided into two fields: one **left**, smaller, and the other **right**, larger, by the **anterior interventricular sulcus**.

– The **auricular segment** overhangs the arterial part and extends laterally and forward by the **auricles**.

  - The **right auricle**, triangular in shape, covers the anterior surface of the origin of the aorta.

- The **left auricle**, with only its anterior tip belonging to the **anterior face** of the heart, has a **sinusoidal shape** and covers the origin of the pulmonary artery. For most of its extent, it is part of the **left** surface.



Anterior view (sternocostal surface)

Left postero-inferior view

A. Atrial part
B. Arterial part
C. Ventricular part
1- Superior vena cava
2- Base of the heart
3- Inferior vena cava
4- Diaphragmatic surface
5- Aortic arch
6- Left pulmonary artery
7- Pulmonary surface
8- Coronary sulcus

General morphology of the heart

b. Inferior surface of the heart:

- **Also called diaphragmatic surface**, rests on the **phrenic center** and is primarily formed by the **right ventricle**.
- It is slightly convex and inclined downward and forward.
- The **ventricular segment** is divided by the **posterior interventricular sulcus** into two unequal fields: the **right**, larger, and the **left**.
- The **auricular segment** is narrower.

c. Lateral surface of the heart:

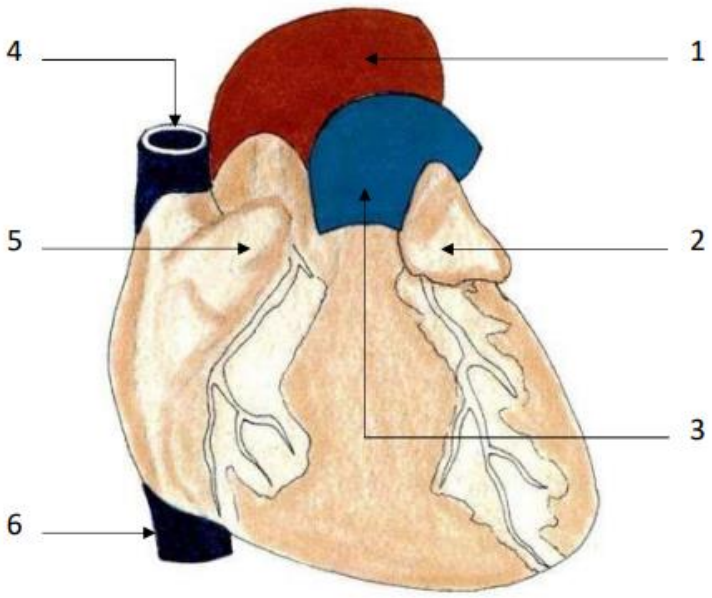
- Also called the **pulmonary face**, it faces **left and backward**, and is convex from top to bottom. This convexity is especially pronounced in the **ventricular segment**.

– In the **auricular segment**, the **left auricle** wraps around the **lateral left side of the pulmonary artery**.

2. Borders of the heart:

The three faces of the heart are separated from one another by three borders that all converge towards the **apex**: one on the right and two on the left.

- The **right edge** is positioned between the **anterior surface** and the **inferior surface** of the heart.
- The **left edges** are rounded and separate the **left lateral surface** from the **anterior** and **inferior surfaces**. One is **superior**, and the other is **inferior**.



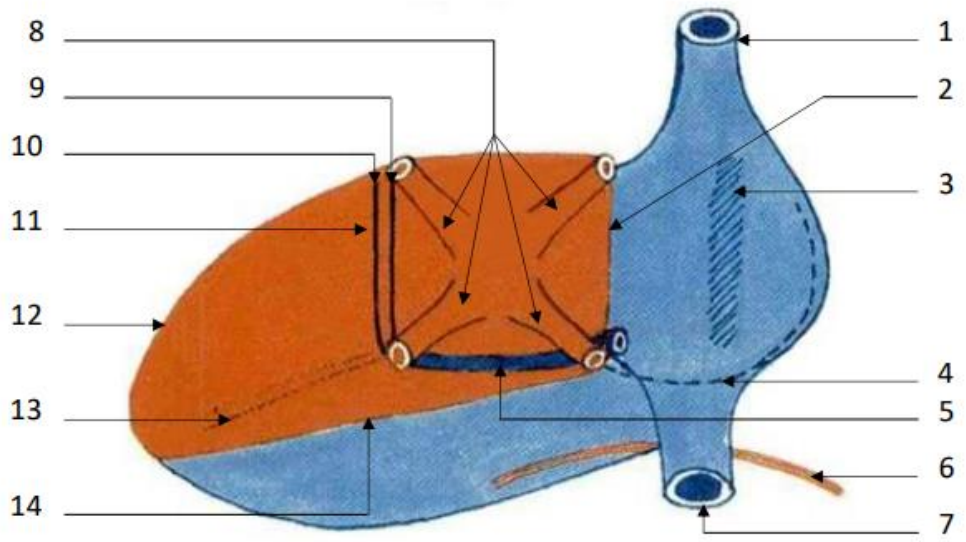
1- Aortic arch
2- Pulmonary artery trunk
3- Left auricle
4- Superior vena cava
5- Right auricle
6- Inferior vena cava

Anterior view of the heart showing the cardiac borders

3. Base of the heart:

Formed by the **atria**, it is roughly **flat** from top to bottom and **transversely convex**. It faces backward and slightly to the right, and is divided by the **interauricular sulcus** into two segments:

- **On the left**, the openings of the **four pulmonary veins** are visible, with two on each side. Between the right and left veins is a large space corresponding to **Haller's pericardial recess**.
- **On the right**, the openings of the **superior** and **inferior venae cavae** are located. The right border of these **caval openings** is joined by a vertical sulcus, the **sulcus terminalis**.



1- Superior vena cava
2- Interauricular sulcus
3- Sulcus terminalis
4- Small cardiac vein
5- Coronary sinus
6- Diaphragm
7- Inferior vena cava
8- Pulmonary veins
9- Vein of Marshall
10- Great cardiac vein
11- Auriculpventricular sulcus
12- Upper left border
13- Lower left border
14- Inferior interventricular sulcus

Schematic posterior view of the heart showing the base and the inferior surface of the heart

4. Apex of the heart:

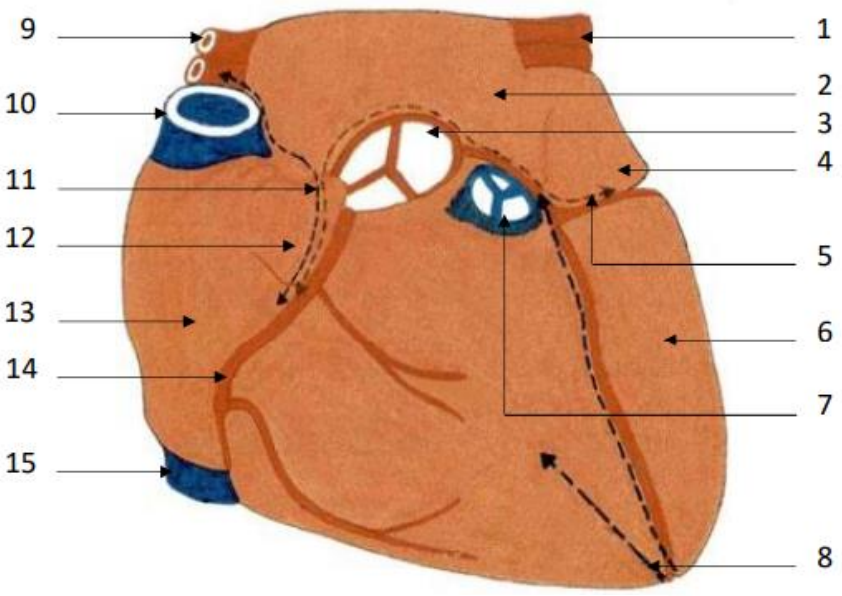
The apex of the heart is divided by a slight depression that connects the **anterior interventricular sulcus** to the **posterior interventricular sulcus** into two parts:

- **The right part**, smaller, corresponds to the **right ventricle**.
- **The left part**, larger, belongs to the **left ventricle** and occupies the very **apex** of the heart.

5. Sulci of the heart:

The sulci of the heart define the outer boundaries of the heart's chambers. The coronary vessels run within them, masked by adipose tissue. Three main sulci can be identified on the heart's surface:

- **The interauricular sulcus**
- **The interventricular sulcus**
- **The auriculoventricular sulcus**



1- Left pulmonary vein
2- Left atrium
3- Aorta
4- Left auricle
5- Auriculoventricular sulcus
6- Left ventricle
7- Pulmonary artery
8- Interventricular sulcus
9- Right pulmonary vein
10- Superior vena cava
11- Interauricular sulcus
12- Right auricle
13- Right atrium
14- Auriculoventricular sulcus
15- Inferior vena cava

Anterior view of the heart showing the various cardiac sulci

a. The interauricular sulcus:

- This sulcus occupies the base of the heart and separates the **right atrium** from the **left atrium**.
- It is **convex on the right** in its upper part and corresponds on the left to the **pulmonary veins**.
- It is **concave on the right** in its lower part and corresponds on the right to the **left border of the opening of the inferior vena cava**.

b. The interventricular sulcus :

- This sulcus is located in a vertical plane passing through the axis of the heart.
- The **anterior and posterior interventricular grooves** separate the **sternocostal** and **diaphragmatic faces** into two fields corresponding to the **right and left ventricles**.
- This groove is traversed by the **interventricular vessels**.

c. The auriculo-ventricular sulcus :

- This groove is located in a plane perpendicular to the axis of the heart. It separates the **atria** from the **ventricles**.
- It is concave anteriorly, encircling the arterial zone of the ventricular field, running along the **right auricle** and curving around the **right border of the heart** to pass onto the **diaphragmatic face**. On this surface, it joins the **posterior interauricular** and **interventricular sulci**.

6. The auricules :

a. Right auricule :

- It is tongue-shaped, measuring 4.5 cm in length and 2.5 cm in width.
- It is triangular with a posterior base, implanted in the right atrium, and has an anterior apex in contact with the right border of the **pulmonary artery**.
- It partially covers the **right auriculo-ventricular sulcus**.

b. Left auricle :

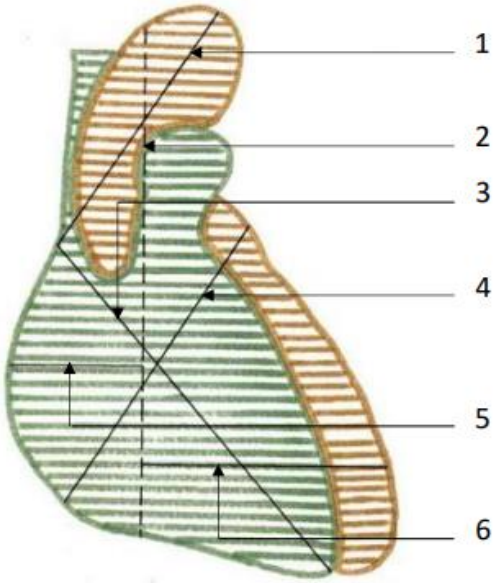
- It is a mitten-shaped diverticulum, measuring 3.5 cm in length and 2.5 cm in width. It is irregular and narrower than the right auricle.
- Its lower border covers the **left interauriculo-ventricular sulcus**, and its apex, in the shape of a hook, hangs over the anterior face of the **left ventricle**.

IV – MEASUREMENTS AND CARDIAC SHAPES:

Radiography allows for the measurement of the cardiac image. It provides information about the shape and size of the heart.

Note : Dextrocardia *is exceptional.*

The possible parameters on a frontal chest X-ray are:



1- Aortic width
2- Midline
3- Longitudinal diameter
4- Transverse diameter
5- Maximum width on the right
6- Maximum width on the left

Anterior view of the heart showing cardiac measurements on the radiological image

1. Maximal transversal diameter :

It is determined **from the midline of the chest**. The maximal width on the right is measured and added to the maximal width on the left.

2. Longitudinal diameter :

It represents the distance **between the notch of the right border of the heart** and the **cardiac apex.**

3. Transversal diameter :

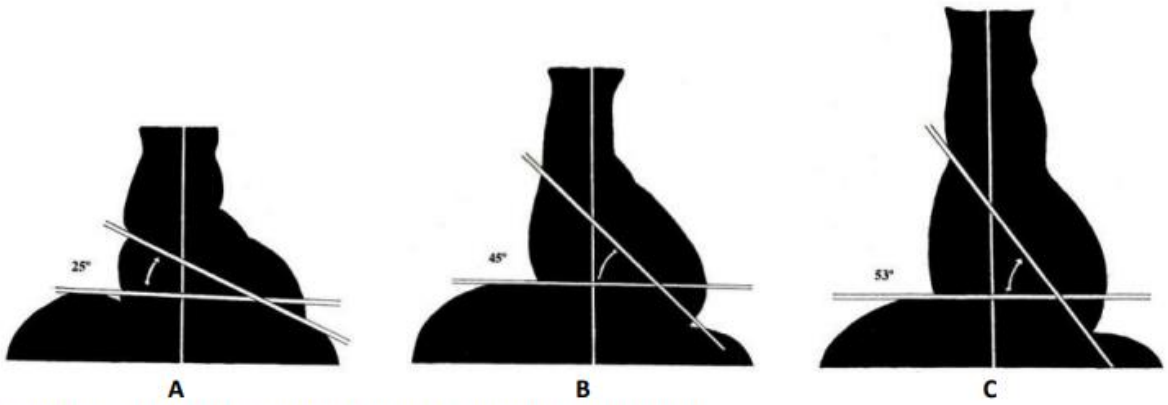
It indicates the **maximum width of the heart**; it is measured **perpendicular to the longitudinal diameter**.

4. Width of the aorta :

It is the distance between the **notch of the right border** of the heart and the **aortic arch**.

5. Cardiac inclination angle :

- It is the angle formed by the longitudinal diameter with the horizontal plane.
- This angle is larger for a vertical heart in a tall, slim individual.
- It is smaller for a flattened heart in a shorter, stockier individual.
- The constitutional variations of the heart are related to those of the entire body and thorax.



A. Flattened heart type
B. Average heart type
C. Vertical heart type

Various morphological types of the cardiac silhouette

V – TOPOGRAPHIC RELATIONS OF THE HEART:

Occupying two-thirds of the **anterior mediastinum**, the heart is in contact, through its pericardial coverings, with the **walls** and **contents of the thoracic cavity**.

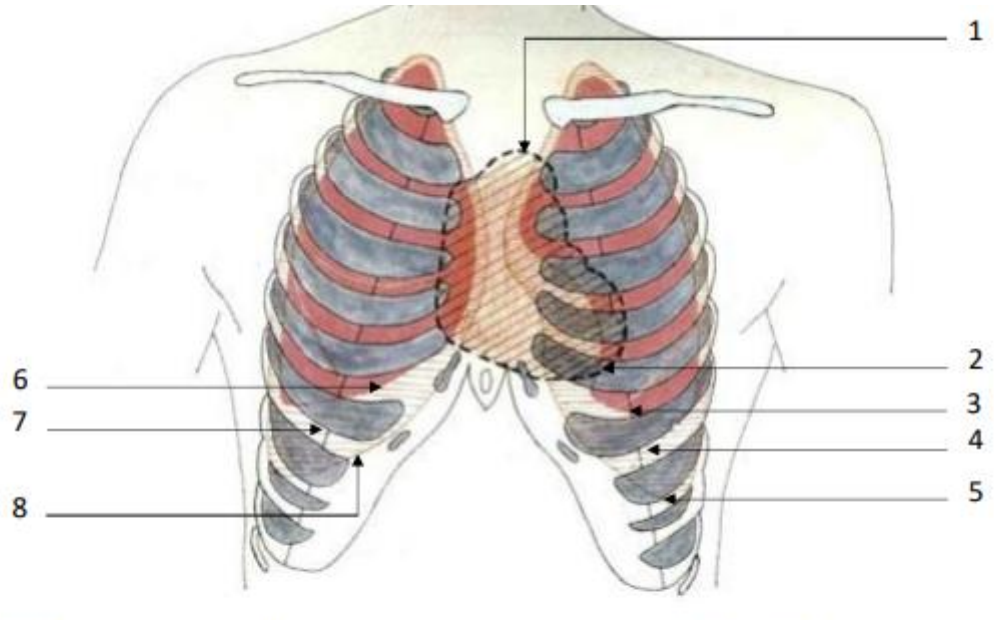
1. Anterior relations:

The anterior relations are primarily represented by:

- The **anterior wall of the thorax**.
- The **viscera** interposed between the heart and this wall.

a. Parietal relations of the heart:

The parietal relations of the heart are represented by **a portion of the thoracic wall** corresponding to the lower three-quarters of the **sternum**, the **third, fourth, and fifth costal cartilages**, and the anterior ends of the corresponding **intercostal spaces**.



1- Aortic knob
2- Apex of the heart
3- Lower border of the left lung
4- Left costo-diaphragmatic recess
5- Lower border of the left pleura
6- Lower border of the right lung
7- Right costo-diaphragmatic recess
8- Lower border of the right pleura

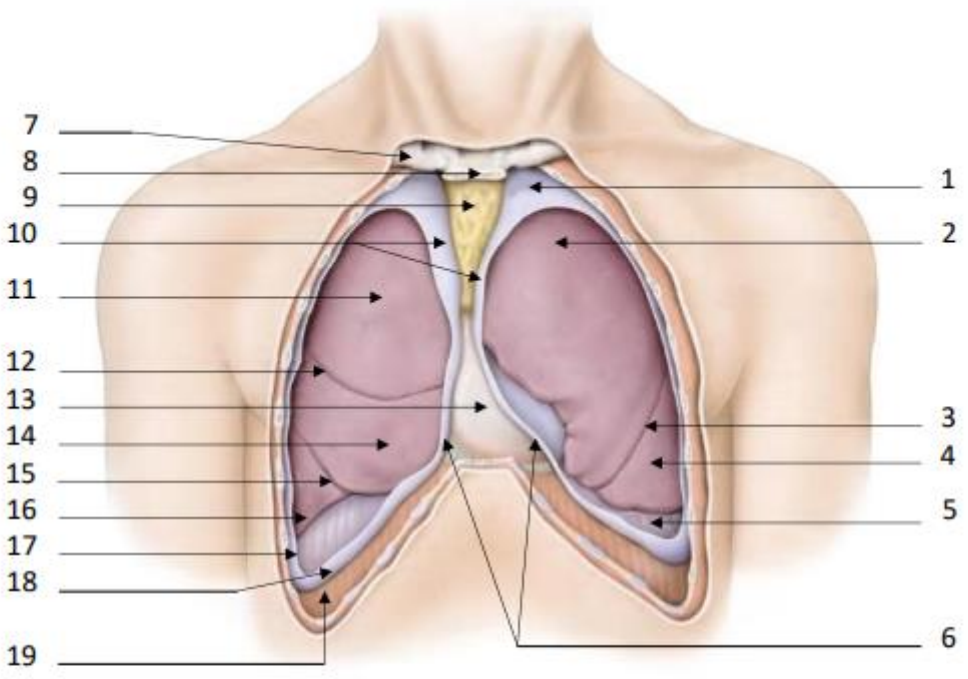
Projection of the cardio-pleuro-pulmonary silhouette on the anterior thoracic

b. Anterior visceral relations :

The anterior visceral relations are represented by:

- The anterior borders of the **lungs**;

- The **pleural recesses**, which diverge downward and outward, delimiting the interpleural triangle corresponding to the area of absolute dullness of the heart.



1- Pleural dome
2- Left upper lobe
3- Left oblique fissure
4- Left lower lobe
5- Left costodiaphragmatic recess
6- Phrenicodiaphragmatic recesses
7- Clavicle
8- Sternum
9- Thymic remnants
10- Mediastinal pleura
11- Right upper lobe
12- Right horizontal fissure
13- Pericardium
14- Middle lobe
15- Right oblique fissure
16- Right lower lobe
17- Costal pleura
18- Diaphragmatic pleura
19- Diaphragm

Lungs in situ (anterior view; pleurae partially resected)

2. Lateral relations:

The heart is in contact on each side with:

- The **mediastinal surface** of each lung, on which it creates, particularly on the left, a depression, the **cardiac notch**;

- The **mediastinal pleura**;
- On the left, the **phrenic nerve** and the **superior left diaphragmatic vessels**.

3. Posterior relations:

The **posterior surface** of the heart or **base**, entirely auricular, is subdivided by the **interauricular sulcus** into two segments, **right** and **left**, each having particular relations.

a. Right segment:

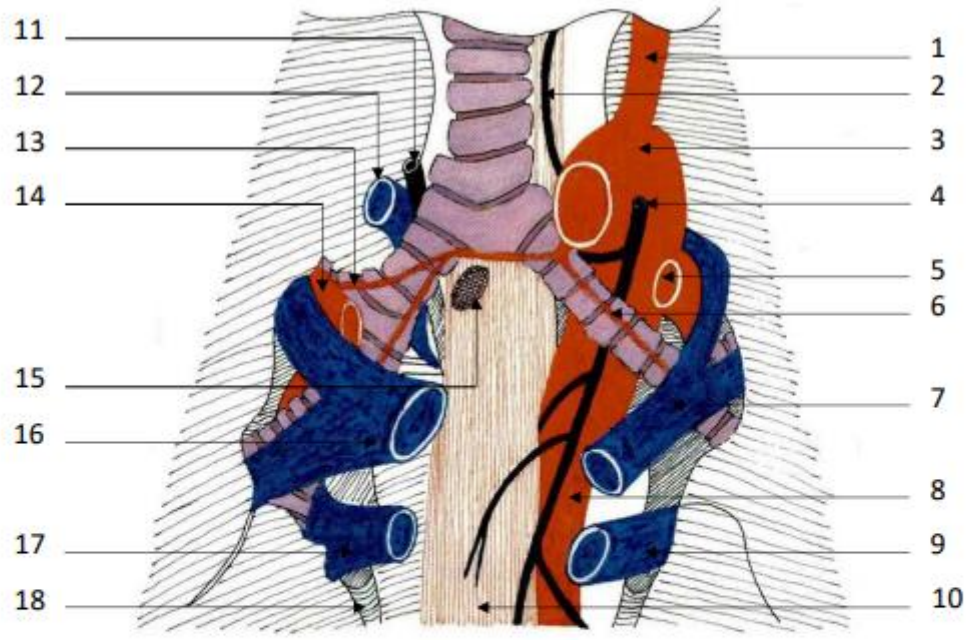
Corresponding to the posterior surface of the **right atrium**, it is in contact with:

- The **mediastinal surface** of the **right lung**, posteriorly.
- The **right phrenic nerve**.
- The **inferior vena cava**.

b. Left segment :

Corresponds to the posterior surface of the **left atrium**. It is in relation with the organs of the **posterior mediastinum**, namely:

- The **esophagus**.
- The two **vagus nerves**.
- The **thoracic aorta**, **thoracic duct**, **azygos vein**.
- And the **vertebral column**.



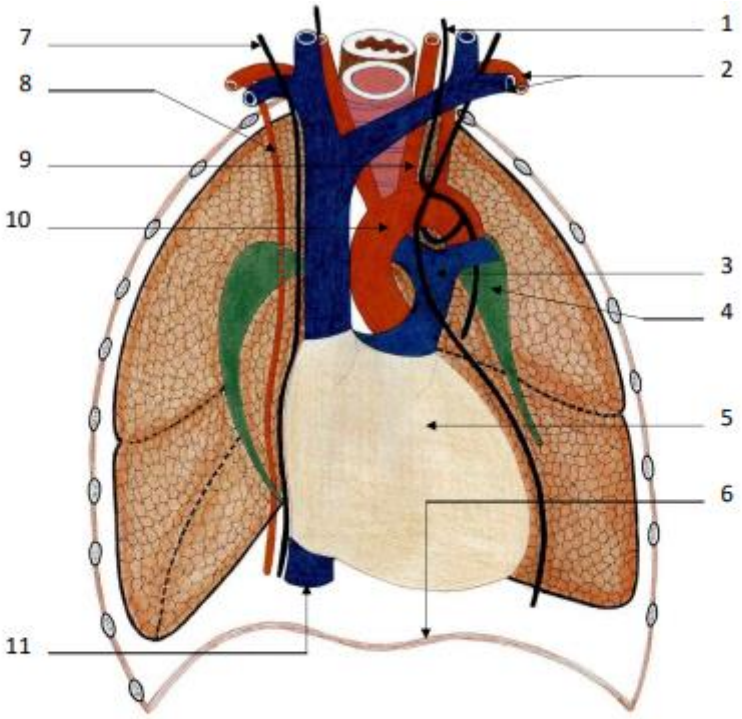
1- Left subclavian artery
2- Left recurrent nerve
3- Aortic arch
4- Left vagus nerve
5- Left pulmonary artery
6- Left bronchial artery
7- Left superior pulmonary vein
8- Thoracic aorta
9- Left inferior pulmonary vein
10- Oesophagus
11- Right vagus nerve
12- Arch of the azygos vein
13- Right bronchial artery
14- Right pulmonary artery
15- Intertracheobronchial lymph node
16- Right superior pulmonary vein
17- Right inferior pulmonary vein
18- Triangular ligament

Anterior view of the tracheal bifurcation after removal of the fibrous pericardial sac, showing the posterior relations of the heart

4. Superior relations:

They are represented by the **upper floor of the mediastinum** and its contents:

- The **large vessels**: **aortic arch**, **pulmonary artery bifurcation**, **brachiocephalic trunks**.
- The **thymic space**.
- The **tracheal bifurcation**.

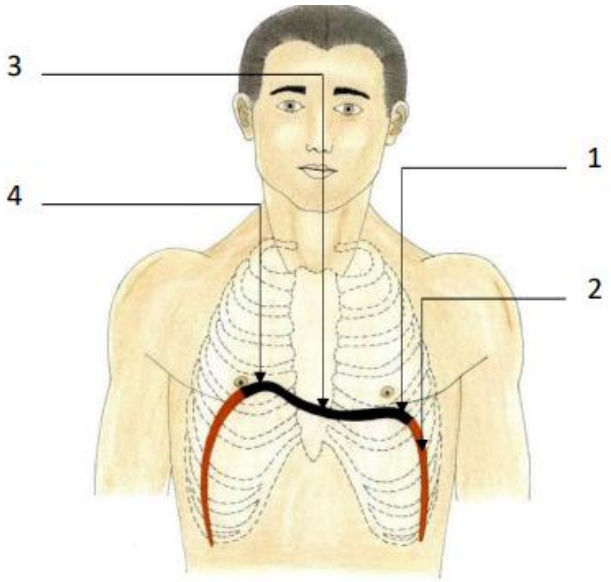


1- Vagus nerve
2- Left subclavian artery and vein
3- Pulmonary artery trunk
4- Triangular ligament
5- Fibrous pericardial sac
6- Diaphragm
7- Phrenic nerve
8- Superior diaphragmatic artery
9- Left common carotid artery
10- Aortic arch
11- Inferior vena cava

Anterior view of the thorax after removal of the sternocostal plate

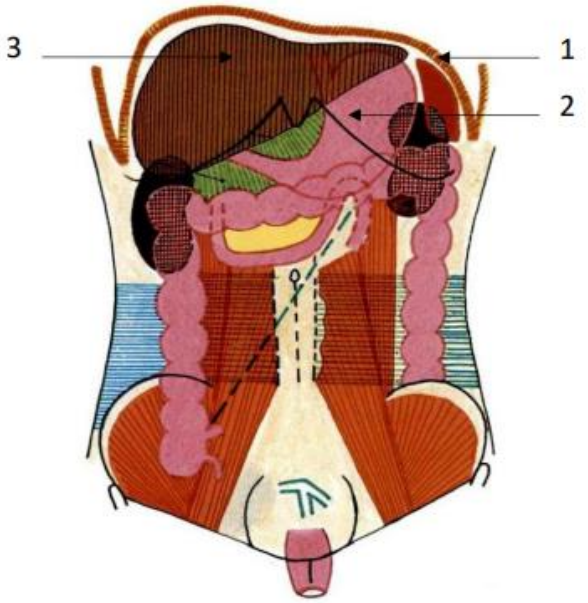
5. Inferior relations:

They are made through the **phrenic center**, with the **large tuberosity of the stomach** and the **left lobe of the liver**.



1- Right dome
2- Tendinous centre of the diaphragm
3- Left dome
4- Muscular part of the diaphragm

Schematic anterior view of the thorax showing the arrangement of the diaphragm

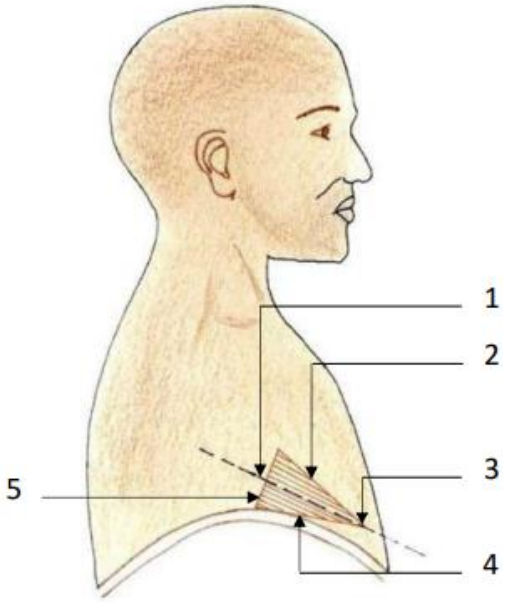


1- Diaphragm
2- Stomach
3- Liver

Schematic anterior view showing the inferior relations of the heart through the diaphragm

6. Apex of the heart:

The heart, in adults, projects inward and below the left nipple, in the **fifth intercostal space**. It is positioned higher in children (**fourth intercostal space**) and lower in the elderly (**fifth intercostal space**).



1- Nearly horizontal axis
2- Sternocostal surface
3- Apex directed anteriorly to the left
4- Diaphragmatic surface
5- Dorsal surface

Schematic lateral view of the thorax

VI – CONCLUSION:

The external configuration of the heart is a complex and intricately organized structure that ensures its proper function within the thoracic cavity.

It is conical in shape, with distinct faces, borders, and a base, which allow it to fit securely between the lungs in the **mediastinum**.

The heart's surfaces, including the **sternocostal**, **diaphragmatic**, and **pulmonary** surfaces, are designed to interact with surrounding structures such as the lungs, pleurae, and major vessels.

Its size, shape, and position in the chest are crucial for its ability to pump blood effectively throughout the body.