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INTRINSIC AND EXTRINSIC INNERVATION OF THE HEART

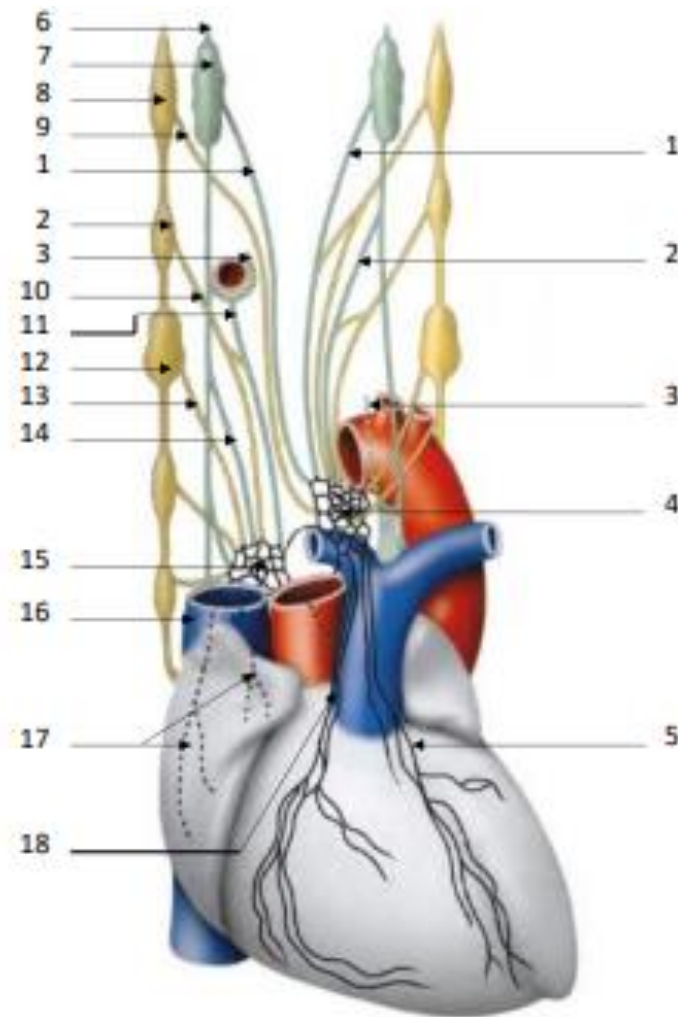
PLAN:

- I. EXTRINSIC INNERVATION OF THE HEART
- II. INTRINSIC INNERVATION OF THE HEART
- III. CONCLUSION

I – EXTRINSIC INNERVATION OF THE HEART:

1. Origin:

- The cardiac nerves are formed by branches of the vagus nerves and the sympathetic nervous system. They extend along the anterior and posterior surfaces of the horizontal part of the aortic arch.
- The nerve structures that reach the heart form, around the great vessels leaving the base of the heart, a nerve plexus called the Wrisberg ganglion (cardiac ganglia), located between the aortic arch and the bifurcation of the pulmonary artery.
- This plexus gives off nerve fibers destined for the large vessels and ends by forming the coronary plexuses or coronary nerves, which follow the coronary arteries.
- There are two coronary plexuses:
 - The left or anterior plexus accompanies the left coronary artery and its terminal branches. It sends fibers to the base of the arterial trunks, the left atrium, and the ventricles.
 - The right or posterior plexus follows the right coronary artery and sends branches to the right atrium.
- Nerve fibers branching from these plexuses form networks that are distributed over the surface of the heart, within the myocardium, and to the endocardium.

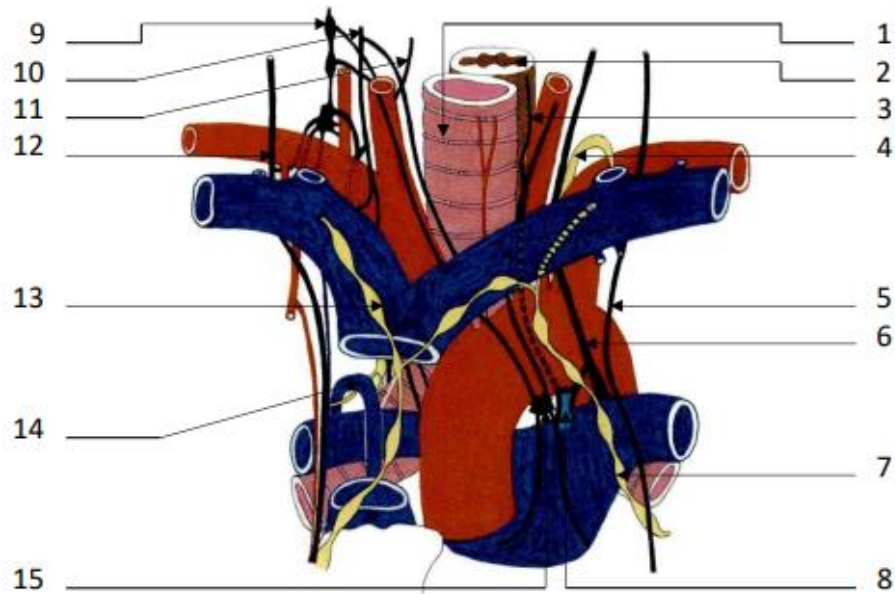


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| 1. Superior cervical cardiac branch | 7. Inferior ganglion of the vagus nerve | 13. Inferior cervical cardiac nerve |
| 2. Middle cervical ganglion | 8. Superior cervical ganglion | 14. Thoracic cardiac branch |
| 3. Recurrent laryngeal nerve | 9. Superior cervical cardiac nerve | 15. Inferior cardiac ganglion |
| 4. Superior cardiac ganglion | 10. Middle cervical cardiac nerve | 16. Inferior vena cava |
| 5. Left coronary nerves | 11. Inferior cervical cardiac branch | 17. Atrial nerves |
| 6. Vagus nerve | 12. Inferior cervical ganglion | 18. Right coronary nerves |

Cardiac nerves and plexuses: schematic overview

Blue: Parasympathetic

Yellow: Sympathetic



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| 1. Trachea | 6. Left vagus nerve | 11. Right recurrent nerve |
| 2. Oesophagus | 7. Left anterior mediastinal lymphatic chain | 12. Right phrenic nerve |
| 3. Left recurrent nerve | 8. Arterial ligament | 13. Right anterior mediastinal lymphatic chain |
| 4. Thoracic duct | 9. Sympathetic chain | 14. Arch of the azygos vein |
| 5. Left phrenic nerve | 10. Right vagus nerve | 15. Wrisberg's ganglion |

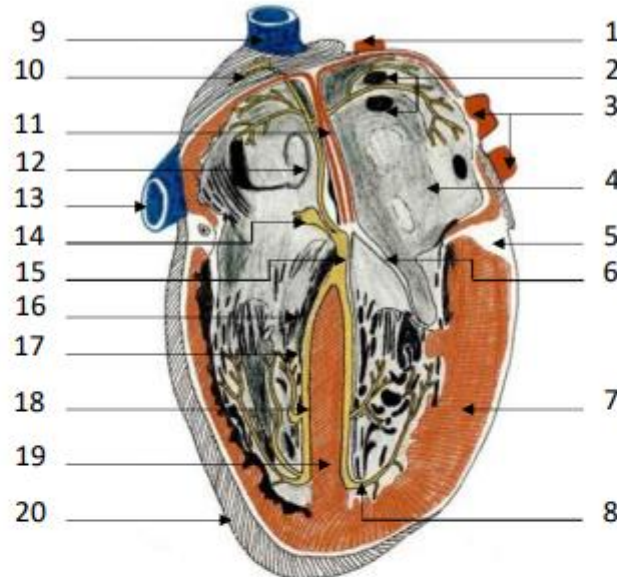
Anterior view of the mediastinum showing the main components

2. Fonction:

- The efferent nerves directed toward the heart adjust cardiac automatism according to the body's needs:
 - Cardiac nerves from the sympathetic chain increase contractile force, conduction, excitability, and heart rate.
 - Cardiac nerves from the vagus nerve reduce these effects.
- There are also afferent autonomic fibres through which cardiac pain is referred to the left arm.

II – INTRINSIC INNERVATION OF THE HEART:

The heart's internal conduction system is a specialized network of muscle fibers and nerve elements responsible for ensuring the propagation of myocardial contraction.



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| 1. Right pulmonary vein | 8. Left branch of the bundle of His | 15. Atrioventricular bundle (bundle of His) |
| 2. Openings of the right pulmonary veins | 9. Superior vena cava | 16. Tricuspid valve |
| 3. Left pulmonary veins | 10. Sinoatrial node | 17. Papillary muscle |
| 4. Left atrium | 11. Interatrial septum | 18. Right branch of the bundle of His |
| 5. Atrioventricular sulcus | 12. Oval fossa | 19. Interventricular septum |
| 6. Atrioventricular valves | 13. Inferior vena cava | 20. Right ventricle |
| 7. Left ventricle | 14. Atrioventricular node | |

Frontal section of the heart showing the arrangement of the chambers and the conduction system

Note:

In case of failure, it can be replaced by an electrical cardiac stimulator, or pacemaker.

1. Sinoatrial node or Keith and Flack node :

- It consists of a cluster of muscle cells that are larger in diameter than those of the myocardium, with a length of 3 centimeters and a width of 3 millimeters.
- This node runs along the posterior wall of the right atrium, in the sulcus terminalis of His.

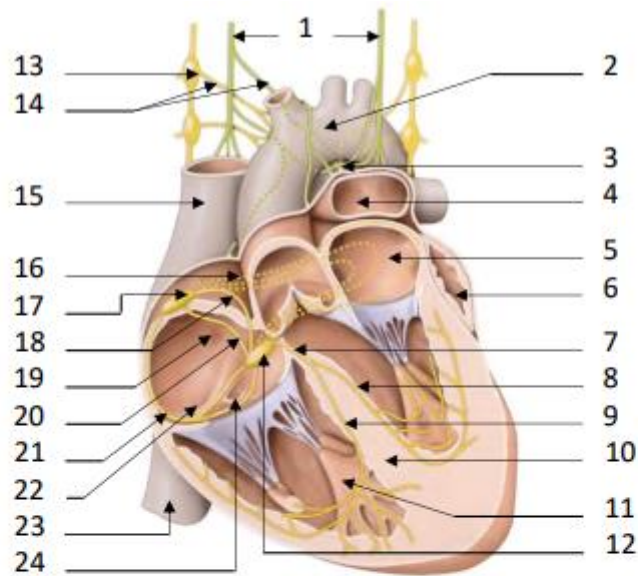
- It begins at the top, beneath the pericardium, on the lateral side of the superior vena cava opening, and descends along the His sulcus.
- After traveling about 2 to 3 cm, it lies in the deep layer of the atrial wall, near the opening of the coronary sinus.
- The excitation wave originating from the sinoatrial node spreads across the atrial wall, then converges towards the Aschoff-Tawara node of the atrioventricular bundle.

2. Atrioventricular bundle or His bundle :

- It connects the muscle of the atria to that of the ventricles, and it is through this bundle that the excitation wave passes from the atria to the ventricular walls.
- It originates in the atrial wall, near the coronary sinus. Its fibres gather into a compact mass called the Aschoff-Tawara node (atrioventricular node), followed by the His bundle trunk.
- This bundle travels forward and upward along the right side of the posterior border of the interventricular septum.
- When it reaches the anterosuperior border of the membranous segment of this septum, it divides into two secondary bundles, one right and one left:
 - The right bundle moves forward, penetrates the ansiform band, which leads it to the base of the anterior and posterior papillary muscles, where it ends.
 - The left bundle, thinner, reaches the left side of the interventricular septum and then descends, broadening, on the left lateral side of the septum. It divides into two groups of fibres, one anterior, the other posterior, which spread and extend to the base of the anterior and posterior papillary muscles of the left ventricle.

- The right and left bundles divide into many branches towards the base of the papillary muscles, forming a wide-meshed subendocardial network known as the Purkinje network.
- The heart's excitation can originate from any part of the conduction system. However, the frequency of the sinoatrial node (70 beats/min) is greater than that of the atrioventricular node (40 beats/min) and the His bundle (20 beats/min), so the rhythm is determined by the sinoatrial node.

Note : *Over the course of a day, the heart is traversed by approximately 900 litres of blood. The activity of the myocardium alternates between relaxation and contraction, thereby ensuring filling (diastole) and ejection (systole).*



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| 1. Vagus nerves | 9. Right branch of the atrioventricular bundle | 17. Sinoatrial node |
| 2. Aorta | 10. Interventricular septum | 18. Anterior internodal tract |
| 3. Cardiac plexus | 11. Septomarginal trabecula | 19. Oval fossa |
| 4. Pulmonary arteries | 12. Atrioventricular node | 20. Middle internodal tract |
| 5. Left atrium | 13. Thoracic sympathetic trunk | 21. Posterior internodal tract |
| 6. Left auricle | 14. Cardiac nerves | 22. Opening of the inferior vena cava |
| 7. Atrioventricular bundle | 15. Superior vena cava | 23. Inferior vena cava |
| 8. Left branch of the atrioventricular bundle | 16. Accessory anterior internodal tract | 24. Opening of the coronary sinus |

Internal conduction system of the heart (frontal section, anterior view)

3. Vascularization of the conducting system :

- The Keith and Flack bundle is supplied by a branch of the anterior auricular artery, which arises from the right coronary artery, and occasionally from the left coronary artery.
- The Tawara node and the main trunk of the His bundle are irrigated by the first of the posterior septal arteries, which originates from the atrioventricular portion of the right coronary artery.

- The right branch of the His bundle receives a branch from the second anterior perforating artery (artery of the anterior papillary muscle of the right ventricle).
- The left branch of the His bundle is vascularised by the anterior and posterior septal arteries.

VII - CONCLUSION:

- The heart's innervation is both intrinsic and extrinsic, ensuring precise control over its rhythm and strength of contraction.
- The autonomic nervous system, through sympathetic and parasympathetic fibres, modulates heart rate and conduction. At the core lies the conduction system, led by the sinoatrial node, which initiates each heartbeat and ensures coordinated propagation through the atrioventricular node, His bundle, and Purkinje fibres.
- This intricate network is finely tuned and richly vascularised, making it essential for maintaining efficient and autonomous cardiac function.