Announcement: Spring Elective Track 2

Cell Engineering BME 376

We will investigate the multiple ways cell behaviors such as proliferation, apoptosis, motility, differentiation can be controlled-- through modulation of 1) genetics and gene expression, 2) signal transduction and 3) the extracellular microenvironment. Assignments will be based on the primary literature.

Reminder: Project

Groups of typically 4 students will create an interactive website that provides a tutorial for one area of quantitative physiology covered in class.

The tutorial should cover:

(1) a review of the relevant physiology,

(2) a review of the associated pathophysiology,

(3) a discussion of the clinical relevance with references from the literature

(4) a recent (last 3 years) development of either scientific, engineering, or medical importance with a brief summary, and a discussion why the development is important.

Project websites will be presented in the discussion meeting.

A detailed scoring rubric has been provided.

Reading this Week

Silverthorn 6th edition: Chapter 14

Chapter 16 will be covered in the 11/25 lecture.

This is an effort to allow you more time to grasp Ch 14 and also help you prepare for a short guest presentation on LVAD technology on 11/18.

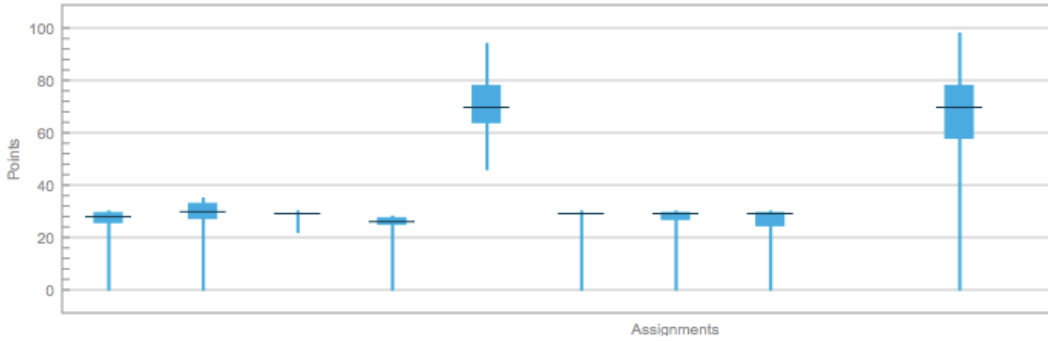
Exam 2 Stats

Average= 66

Standard Dev= 18

Grades

Each bar is one assignment. The thin vertical whisker extends from the lowest score for any student in the course to the highest score. The thicker bar extends from the 25th percentile to the 75th, with the median marked.



CARDIOVASCULAR PHYSIOLOGY

Engineering Physiology I

BME 365R

11/11/2014

Outline for this week

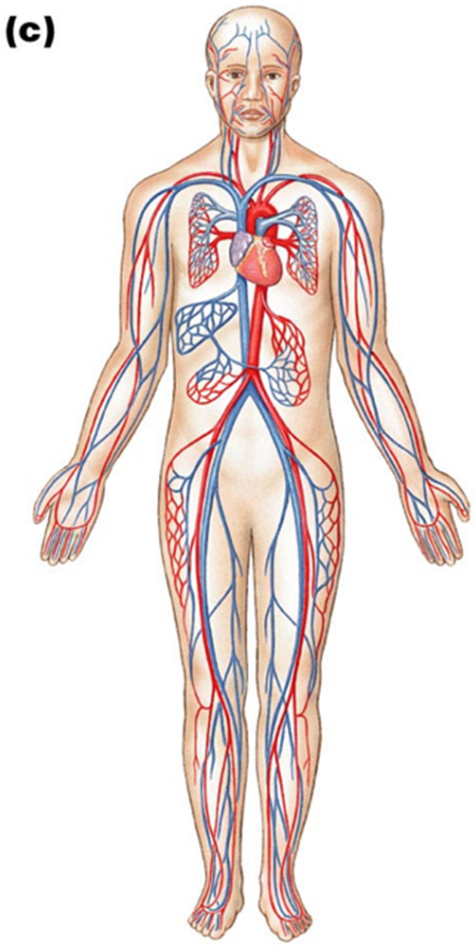
- Overview of cardiovascular system
- Heart anatomy
- Heart as a pump: mechanical aspects
  - Pressure-Volume loop
  - Frank-Starling Law and stroke volume
  - Preload and afterload
- Heart as a pump: electrical aspects
  - Cardiac muscle cell

OVERVIEW OF CARDIOVASCULAR SYSTEM

Cardiovascular System (CV)

- Heart
- Blood Vessels
- Blood

Functions of the CV System



CV System Transports Materials throughout the body

1) Nutrients, water, and gases.

2) Materials that move from cells to cells (e.g., hormones, cytokines)

3) Wastes (CO_2, metabolic waste, heat)

Major Organ Systems

Brain

Lungs

Liver

Digestive tract

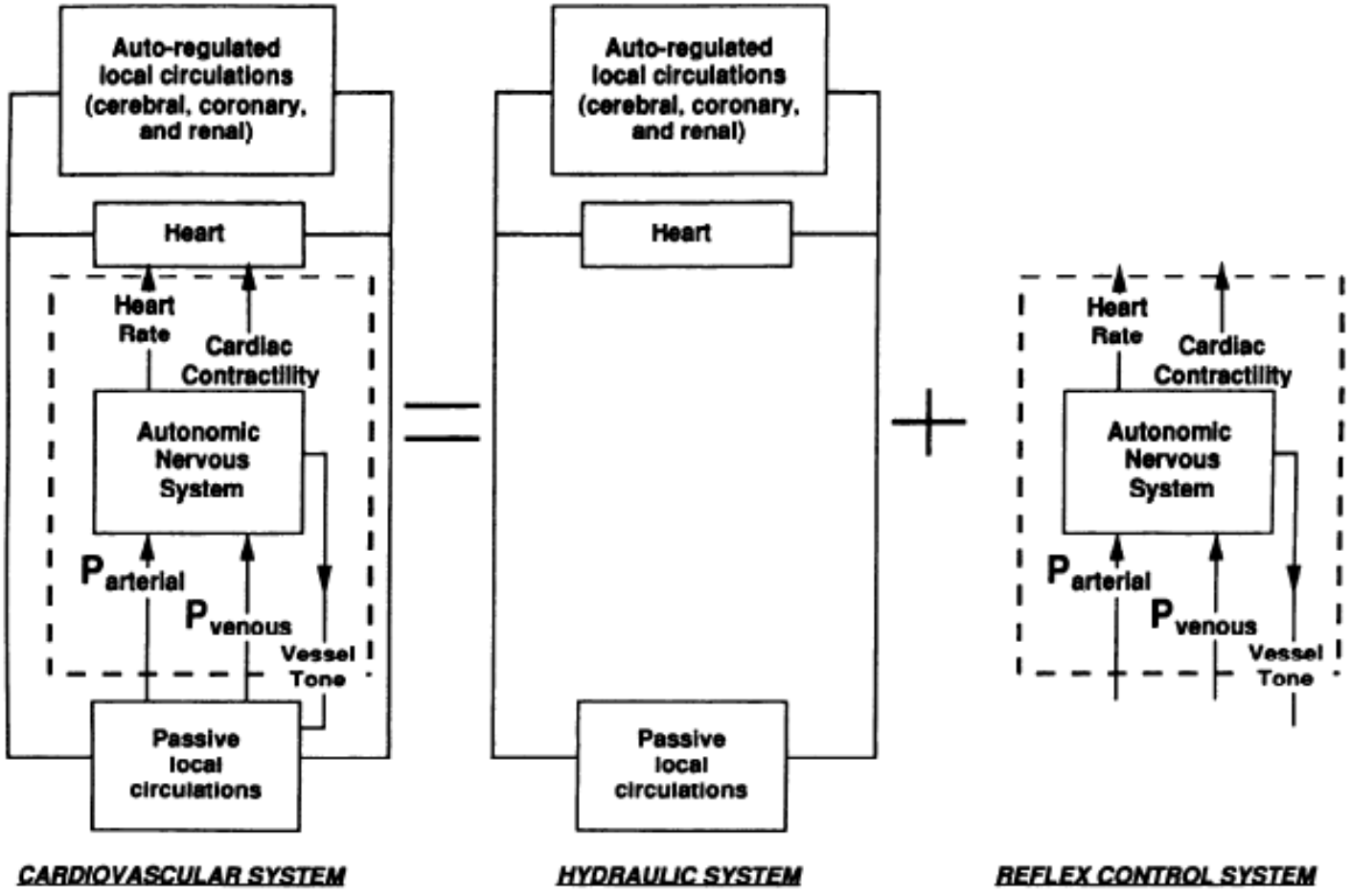
Kidneys

Skeletal muscles

Adipose

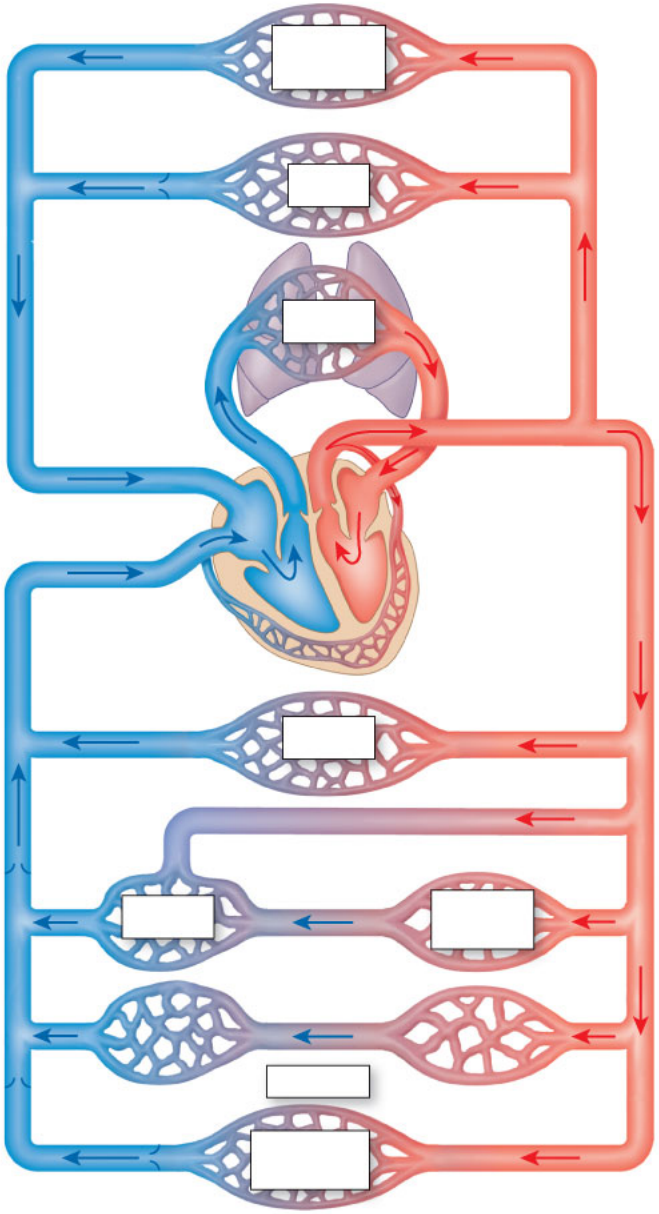
Skin

Cardiovascular System – Function/ Control Overview



"Mathematical modeling of human cardiovascular system for simulation of orthostatic response," Heart and Circulatory Physiology, H1920 – H1933, 262(6) 1992

The Cardiovascular System

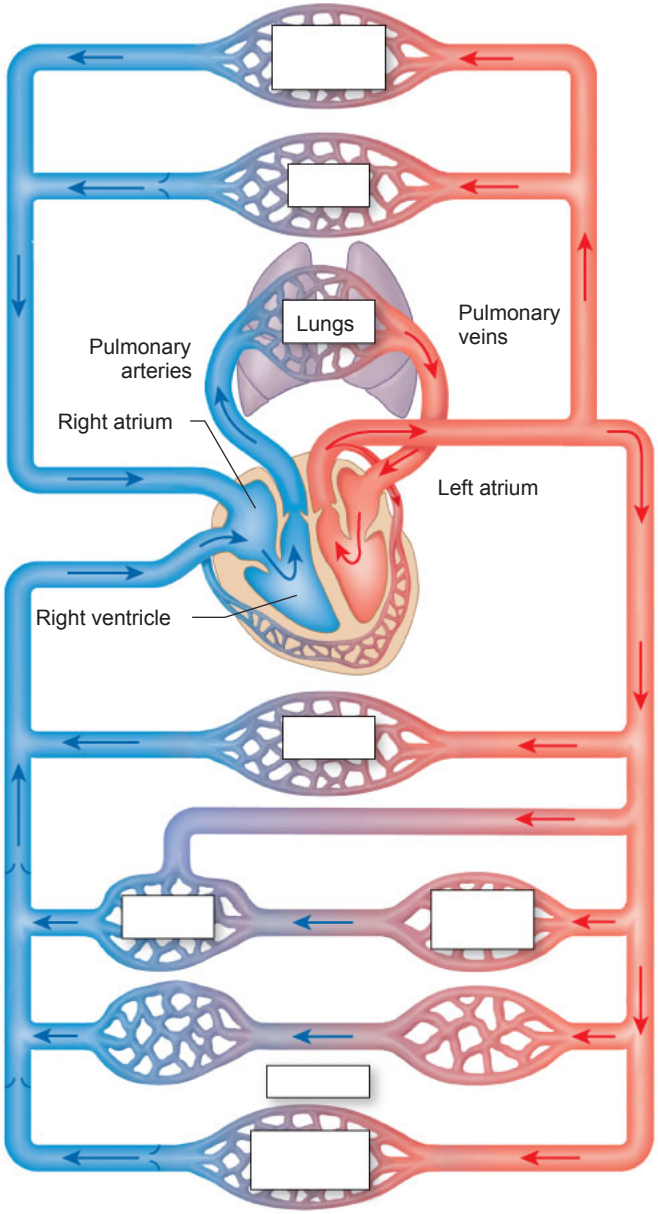


Definition – blood vessels that carry blood from the heart are called ***arteries*.**

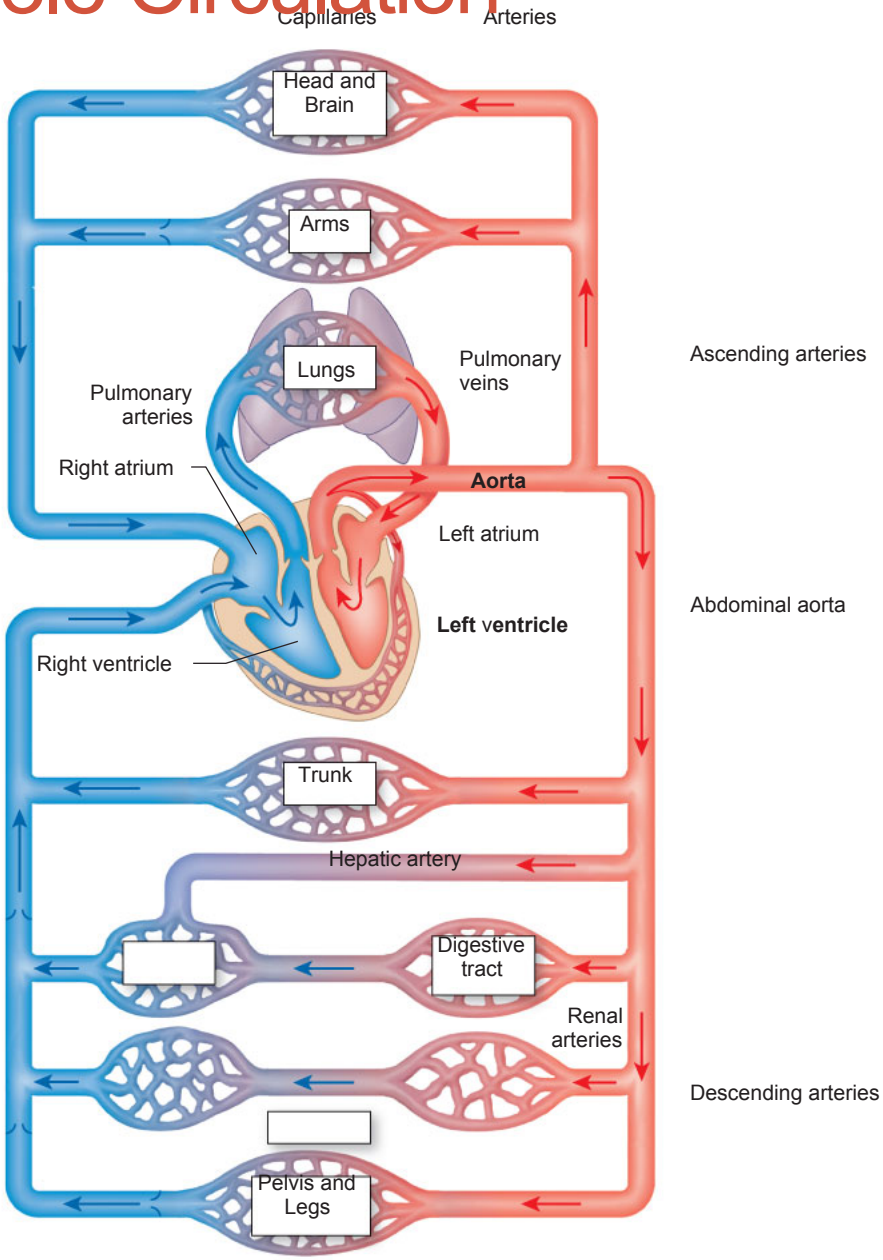
Blood vessels that return blood to the heart are called ***veins***.

Valves in the heart and veins ensure uni-directional flow

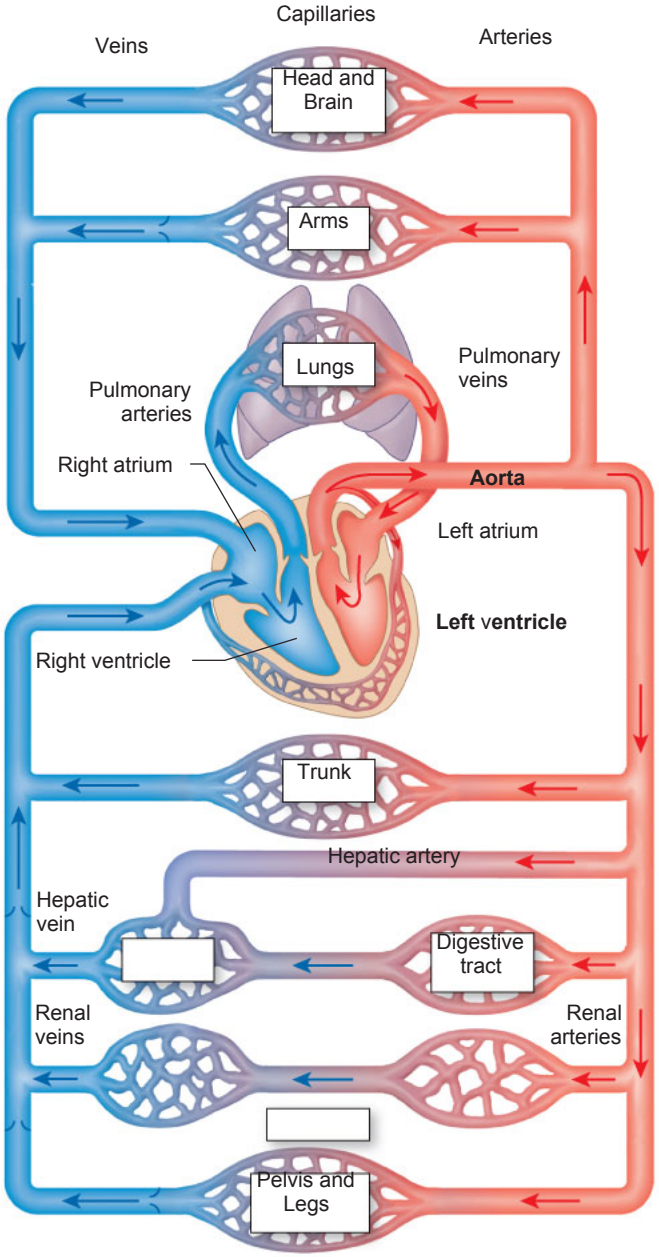
Pulmonary Circulation



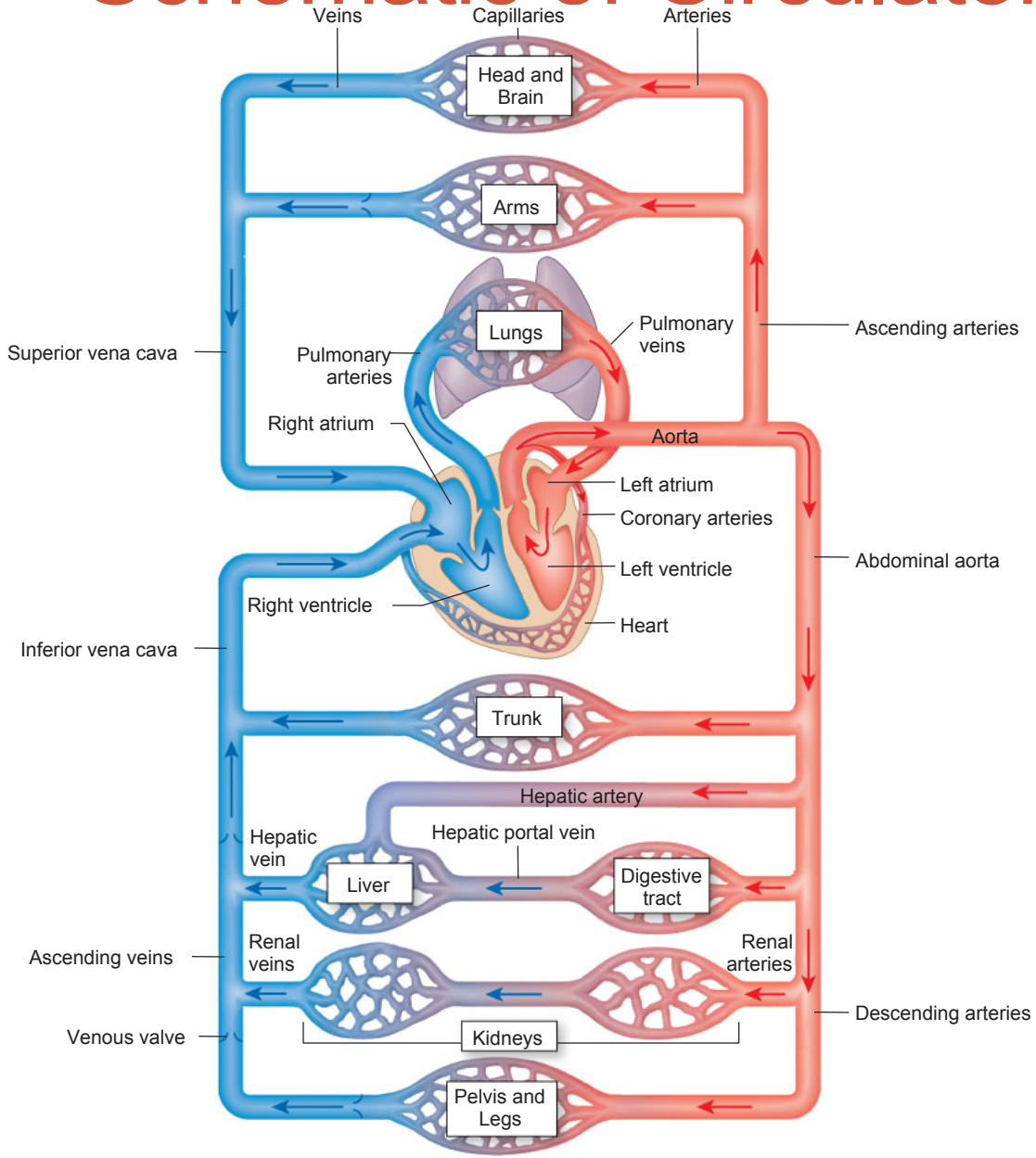
Arteriole Circulation



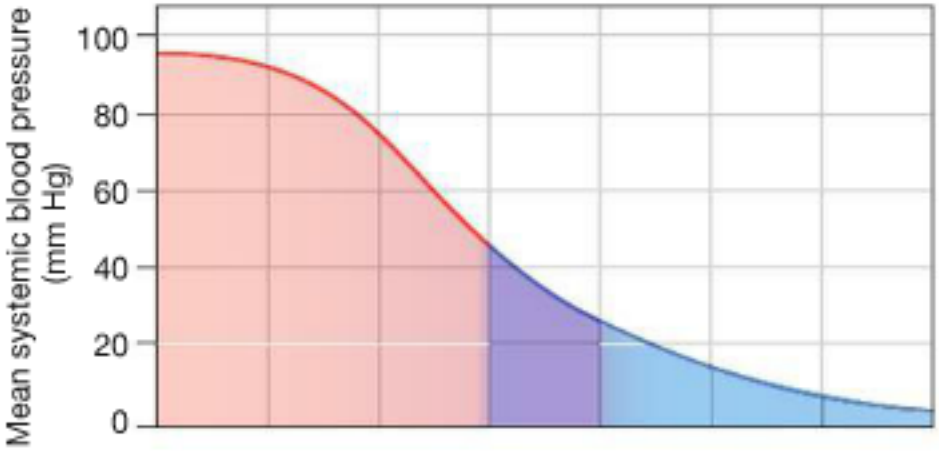
Venous Circulation



Schematic of Circulatory System



Pressure Gradients



HEART ANATOMY

Heart Stats

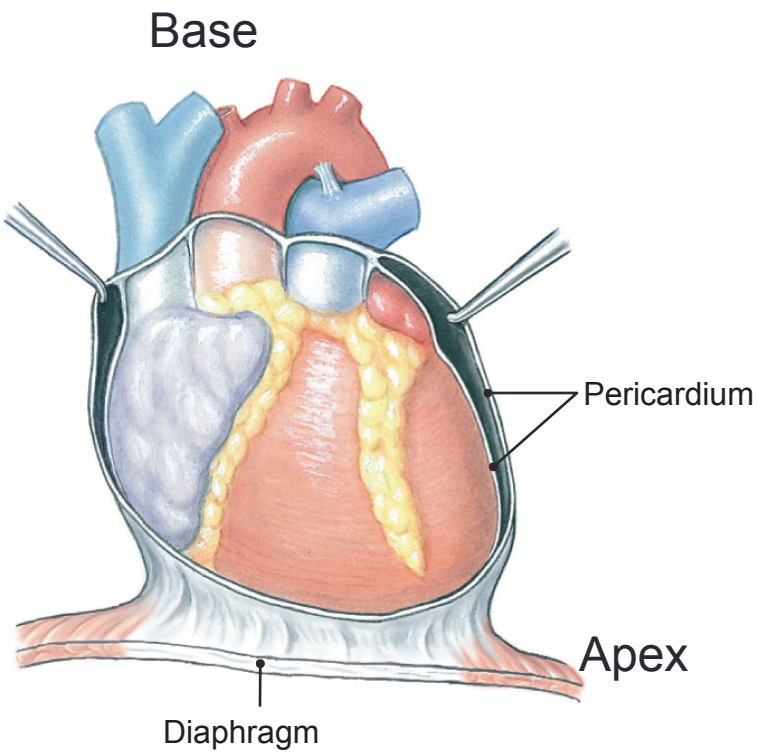
The average heartbeat is 72 times per minute. In the course of one day it beats over 100,000 times. In one year the heart beats almost 38 million times, and by the time you are 70 years old, on average, it's made it to 2.5 billion beats.-

Heart Stats

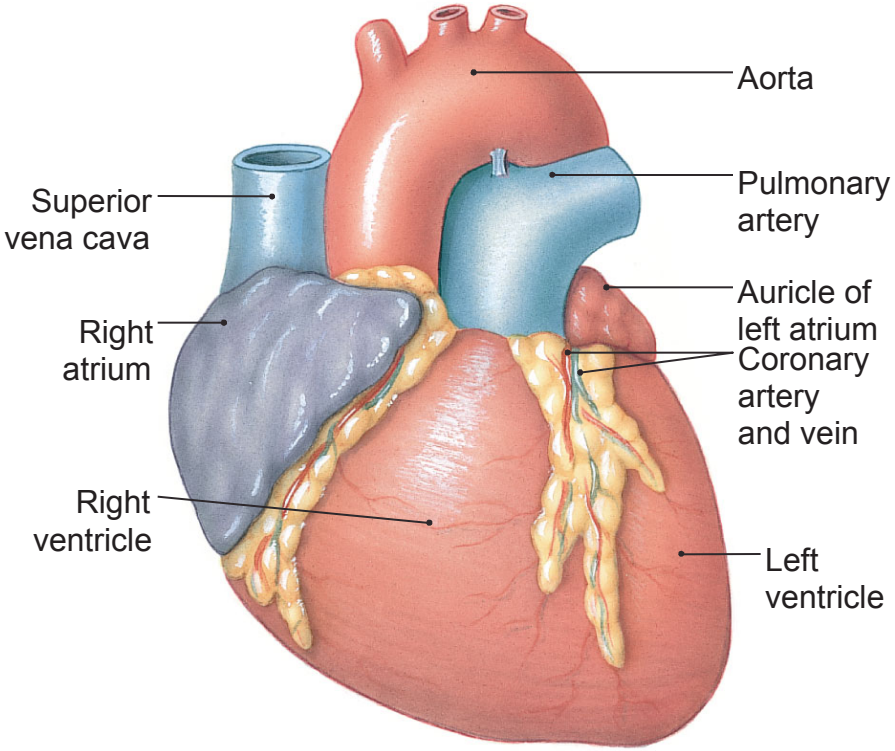
An average heart pumps 2.4 ounces (70 milliliters) per heartbeat. And, as we already mentioned, an average heartbeat is 72 beats per minute. Therefore an average heart pumps 1.3 gallons (5 Liters) per minute. In other words it pumps 1,900 gallons (7,200 Liters) per day, almost 700,000 gallons (2,628,000 Liters) per year, or 48 million gallons (184,086,000 liters) by the time someone is 70 years old. That's not bad for a 10-ounce pump.

Heart Anatomy

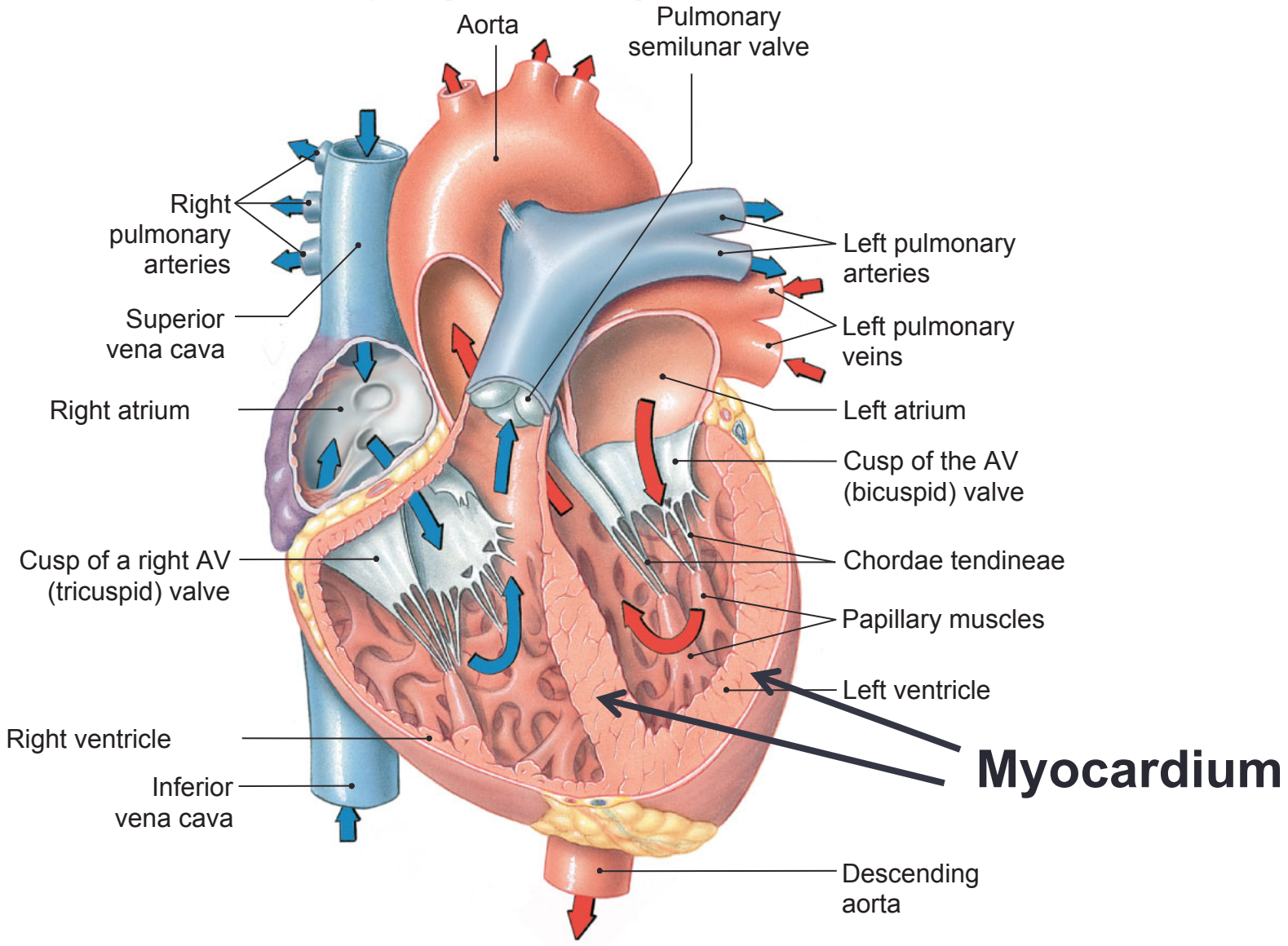
The heart is encased within a membranous fluid-filled sac, the ***pericardium***.



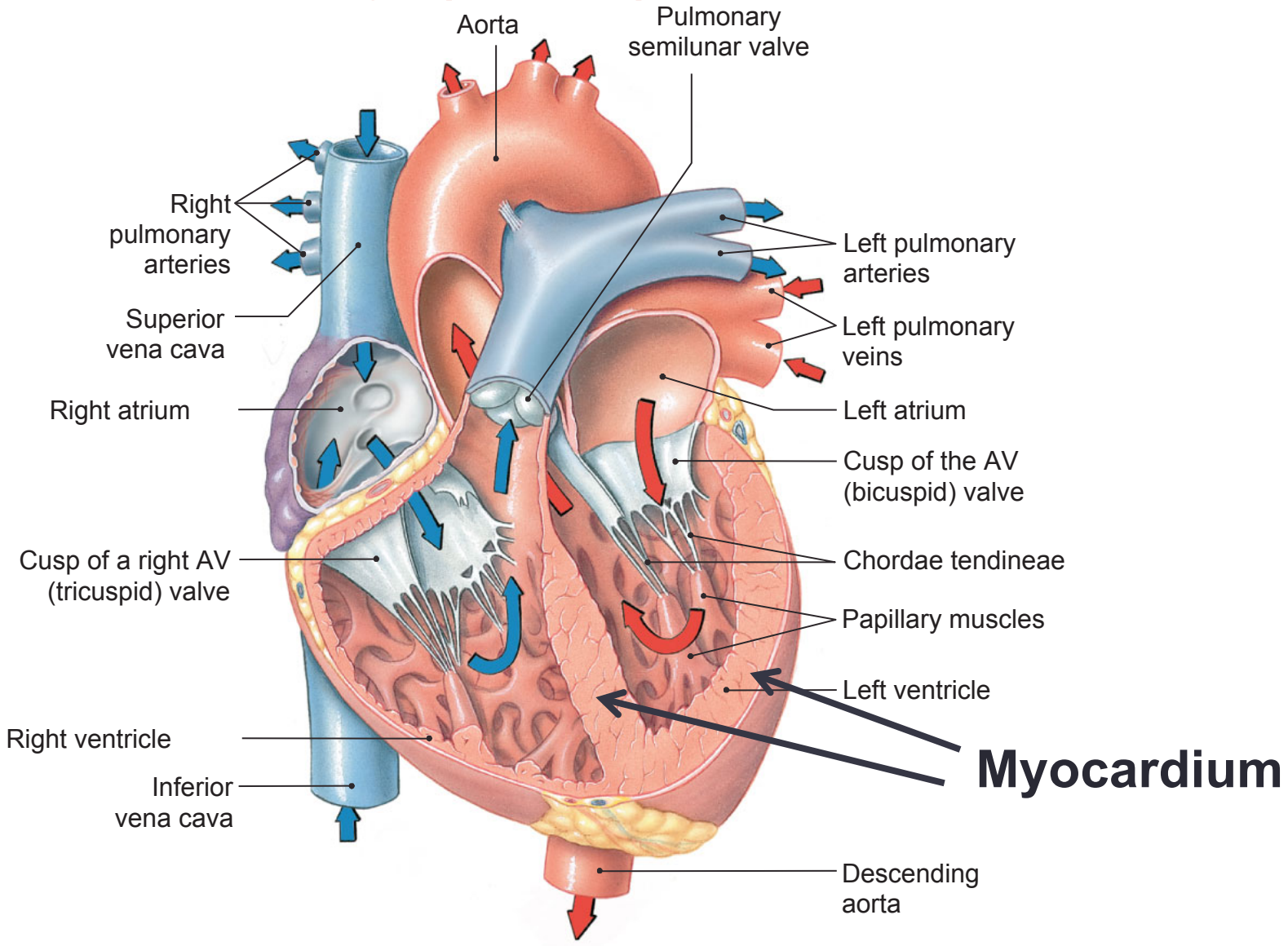
The ventricles occupy the bulk of the heart. The arteries and veins all attach to the base of the heart.



Heart Anatomy (cont.)



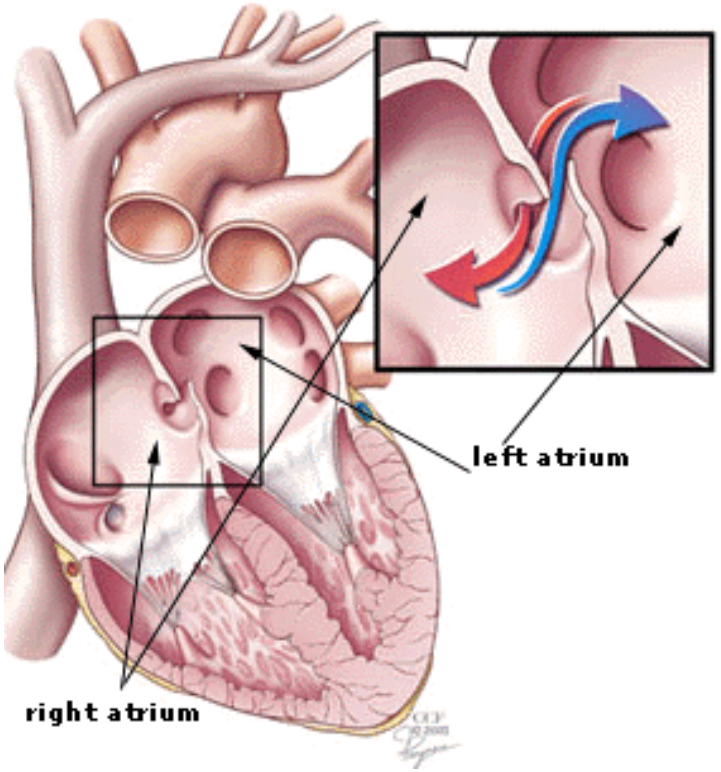
Heart Anatomy (cont.)



HEART AS A PUMP

Mechanical aspects

Common heart defect: patent foramen ovale (PFO)



- PFO is a defect in the septum (wall) between the two upper (atrial) chambers of the heart.
- The defect results in the creation of a flap or a valve-like opening in the atrial septal wall.
- A PFO is present in everyone before birth but seals shut in about 80% of people.
- Less than 1% has a stroke or other outcome that results in the need to have the PFO closed.
- There could be an association between PFO and migraines.

Heart Development

http://www.youtube.com/watch?v=9ARW7kAK4u4&feature=related

Major Blood Vessels

TABLE 14-2 The Heart and Major Blood Vessels

Blue type indicates structures containing blood with lower oxygen content; red type indicates well-oxygenated blood.

	RECEIVES BLOOD FROM	SENDS BLOOD TO
Heart		
Right atrium	Venae cavae	Right ventricle
Right ventricle	Right atrium	Lungs
Left atrium	Pulmonary veins	Left ventricle
Left ventricle	Left atrium	Body except for lungs
Vessels		
Venae cavae	Systemic veins	Right atrium
Pulmonary trunk (artery)	Right ventricle	Lungs
Pulmonary vein	Veins of the lungs	Left atrium
Aorta	Left ventricle	Systemic arteries

Heart Valves

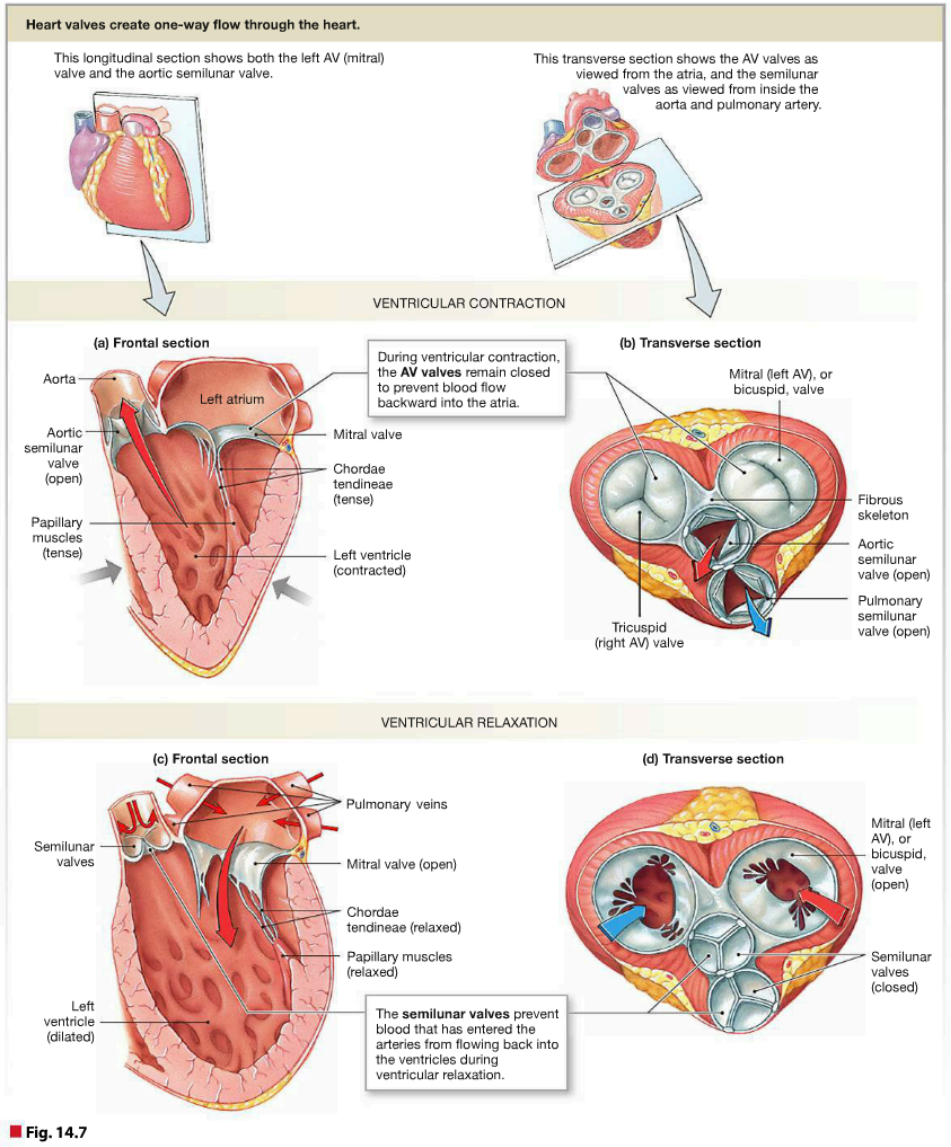


Fig. 14.7

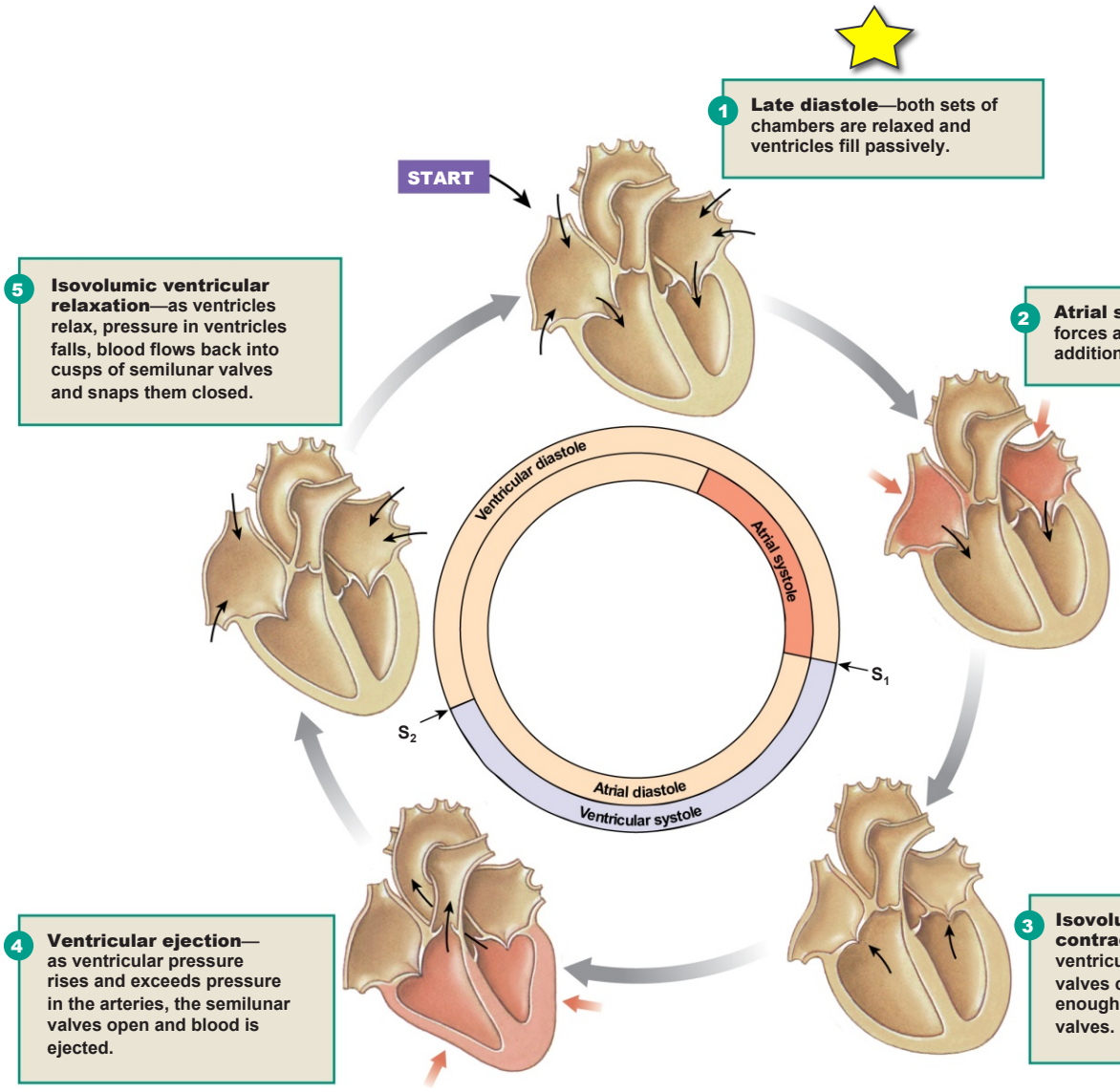
AV valves: between each atrium and ventricle

Tricuspid valve: between RA and RV
Bicuspid/mitral valve: between LA and LV

Semilunar valves: between each ventricle and arteries

-Aortic semilunar valve: between LV and aorta
- Pulmonary semilunar valve: between RV and pulmonary artery

Cardiac cycle: mechanical events



Two phases:

Diastole - cardiac muscle relaxes

Systole – cardiac muscle is contracting

Left and right atria go through systole and diastole simultaneously

Left and right ventricles go through systole and diastole simultaneously

Cardiac cycle: mechanical events

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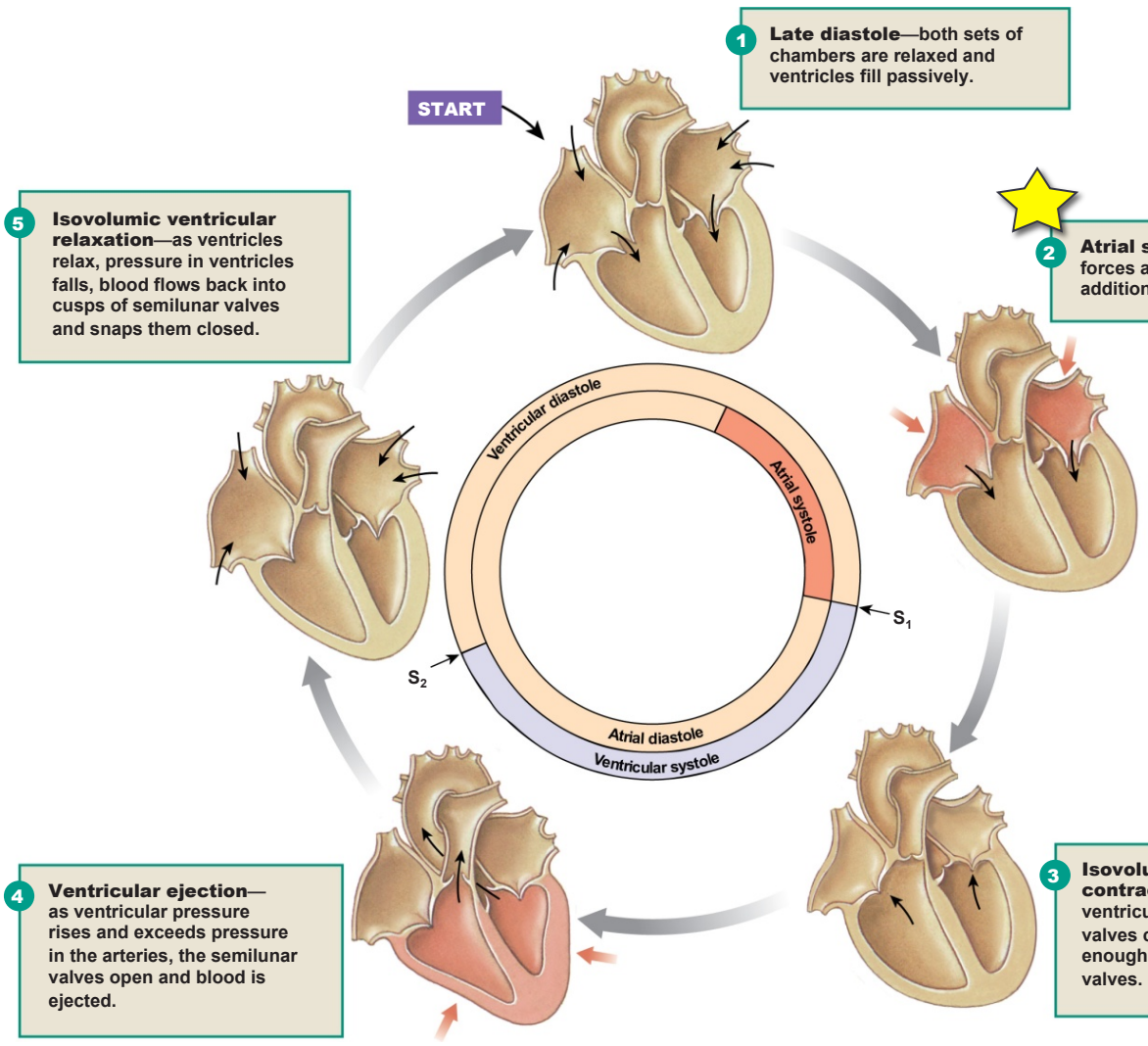

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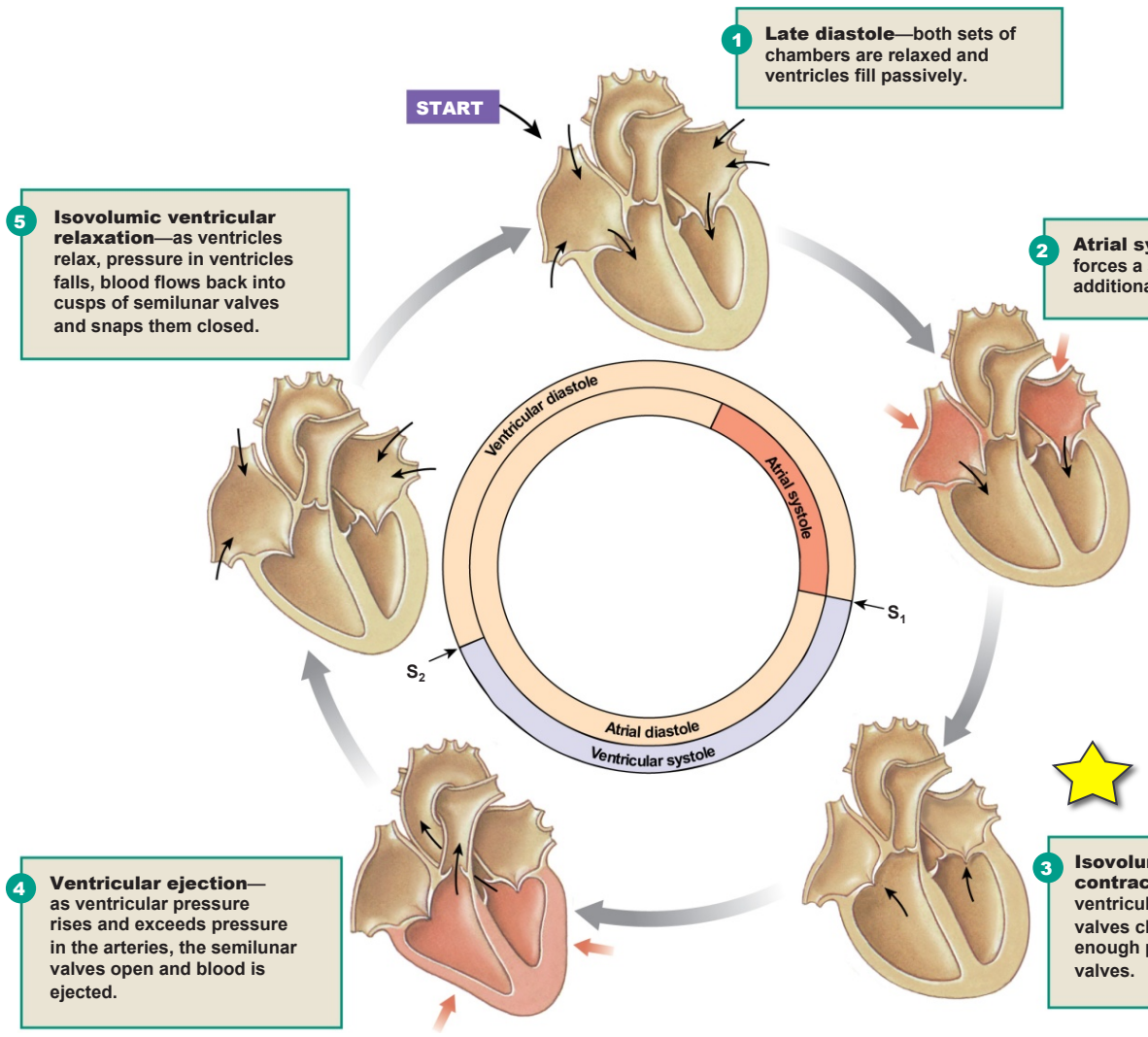

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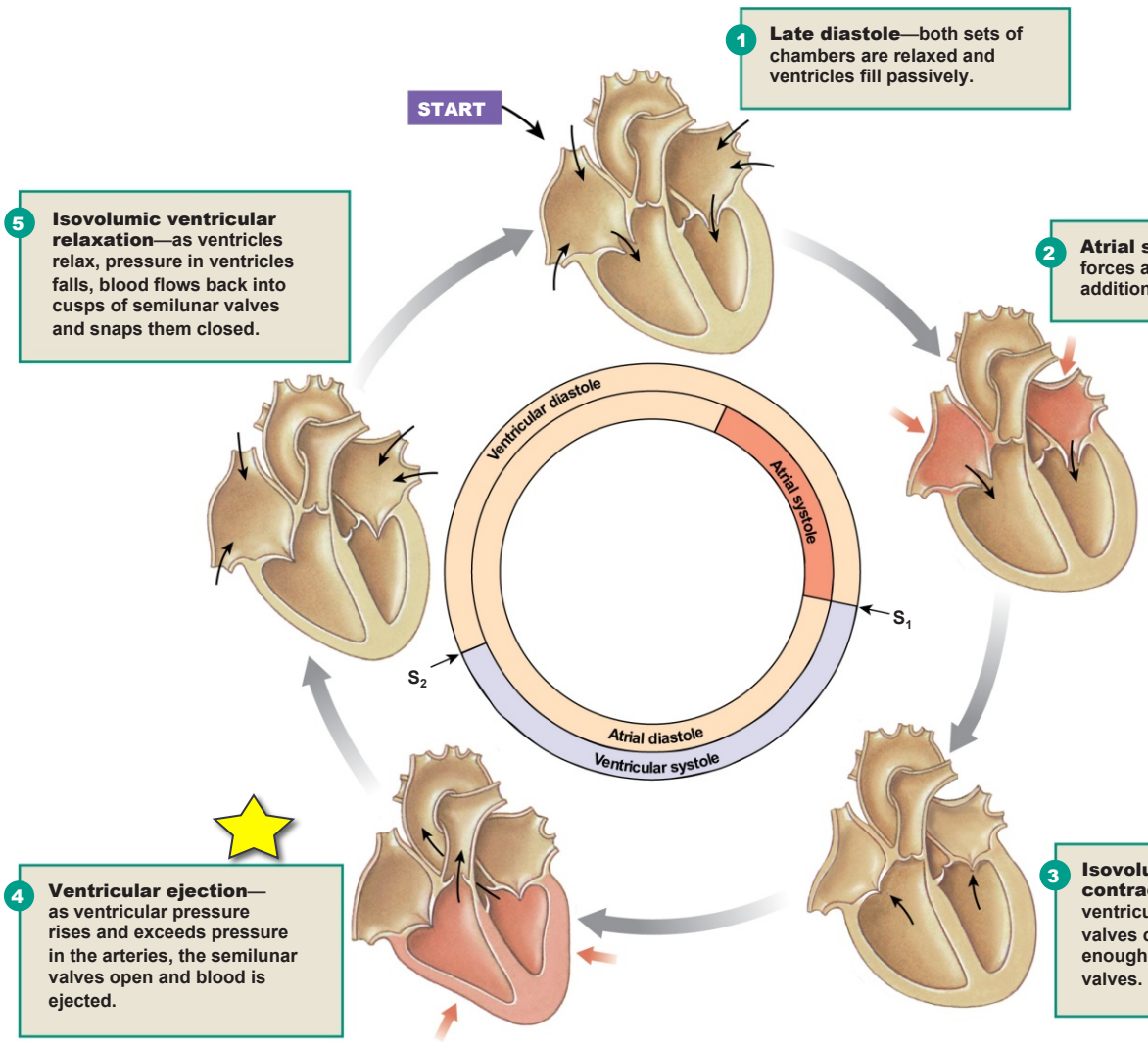

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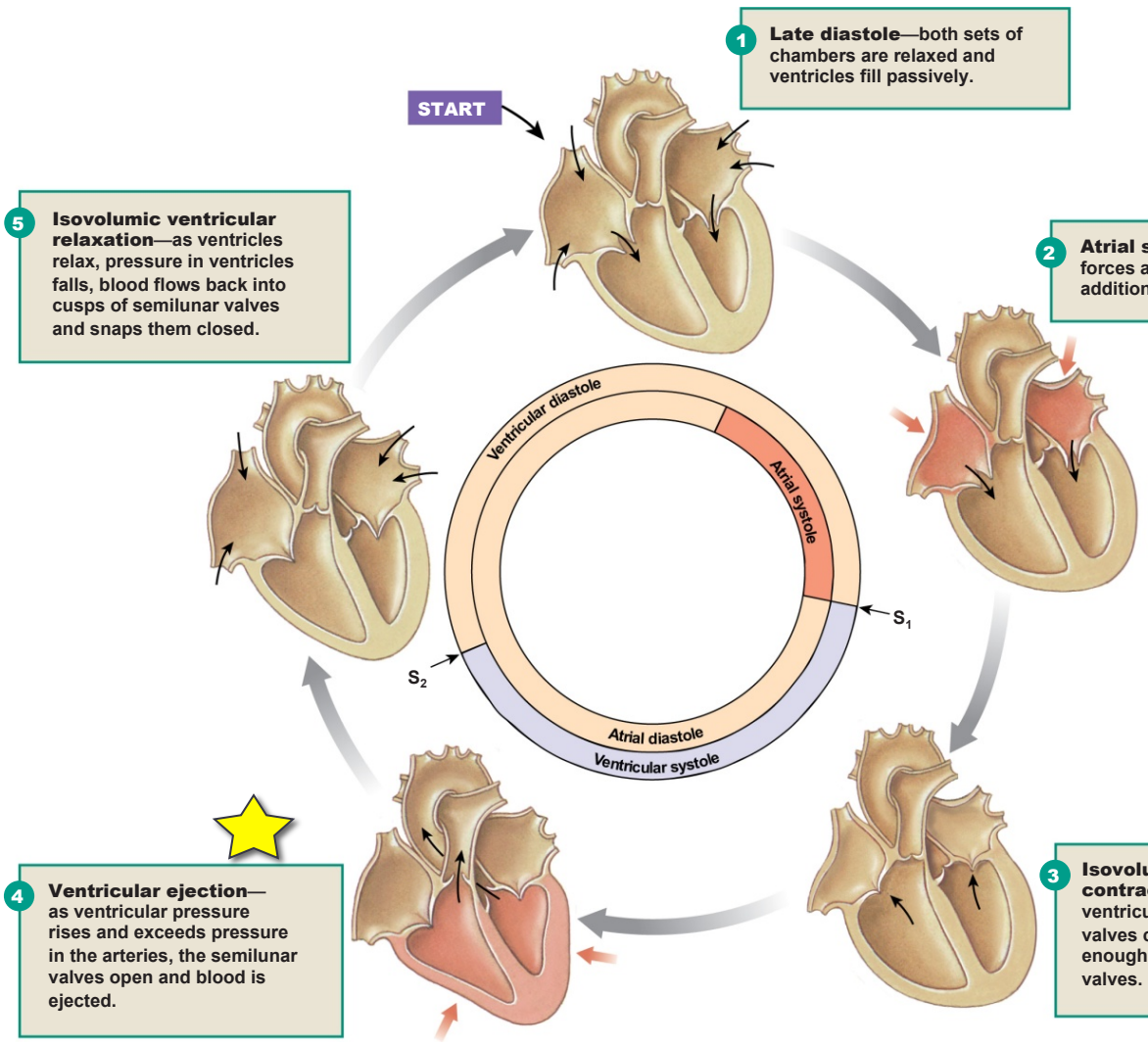

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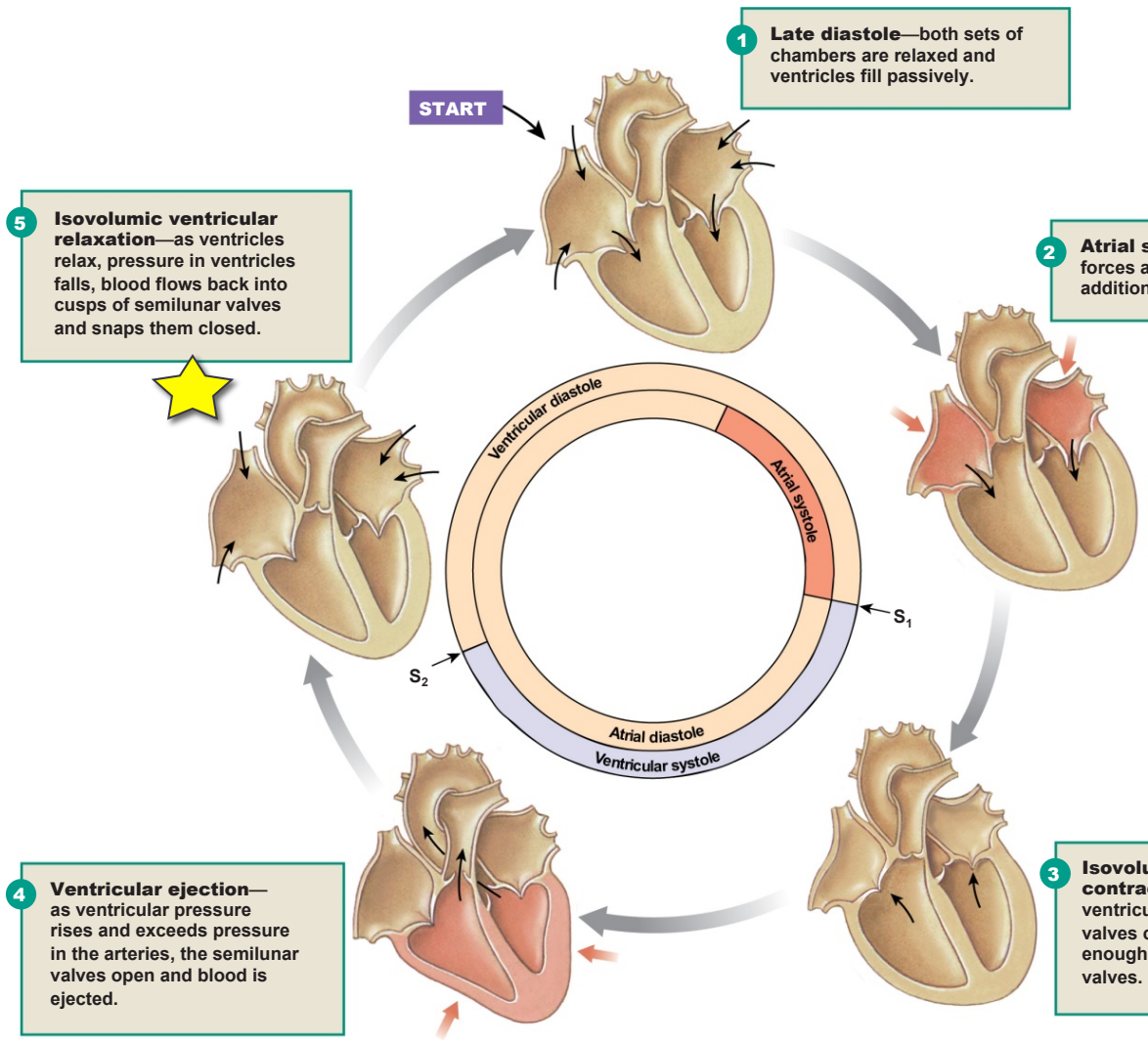

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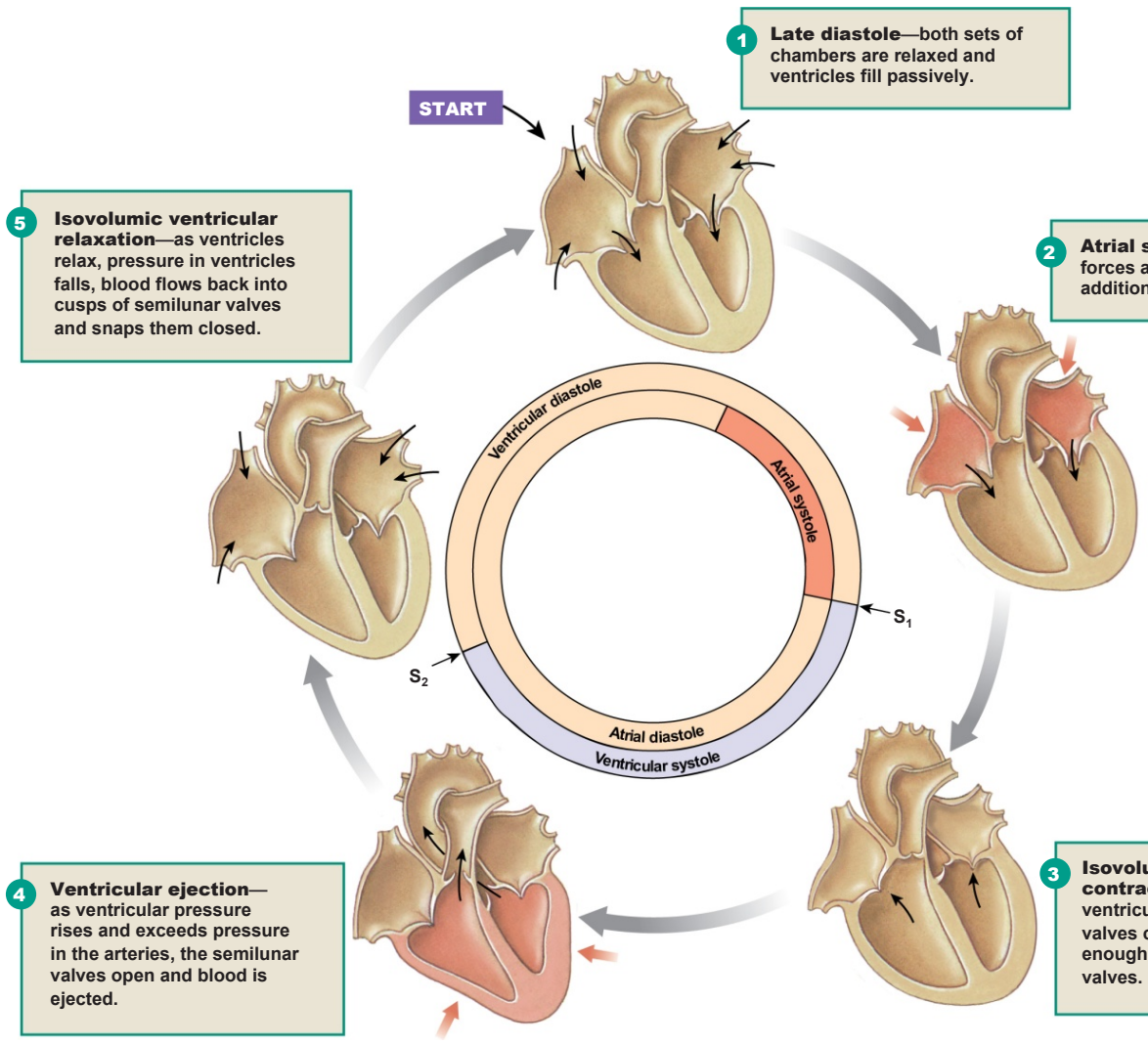

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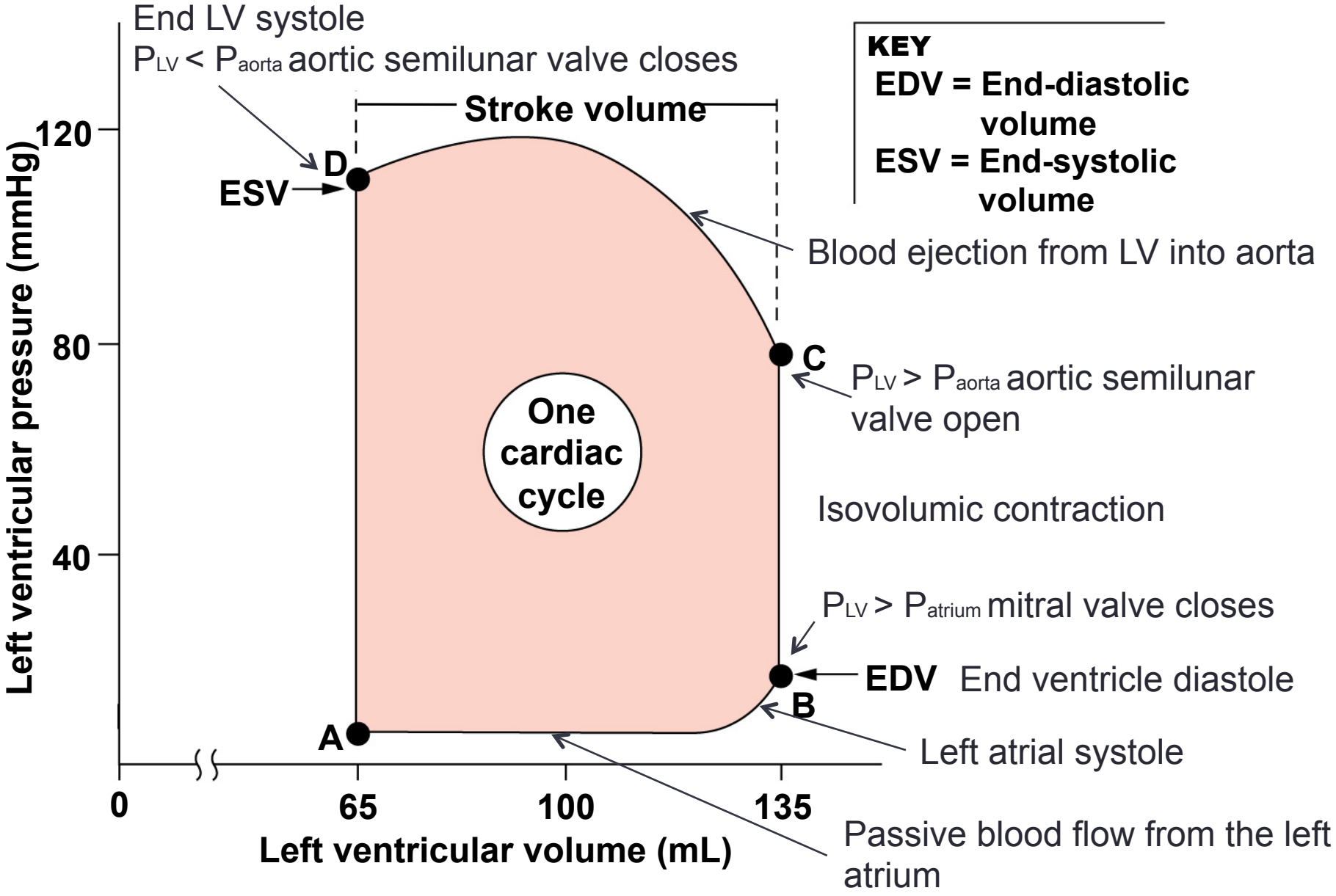
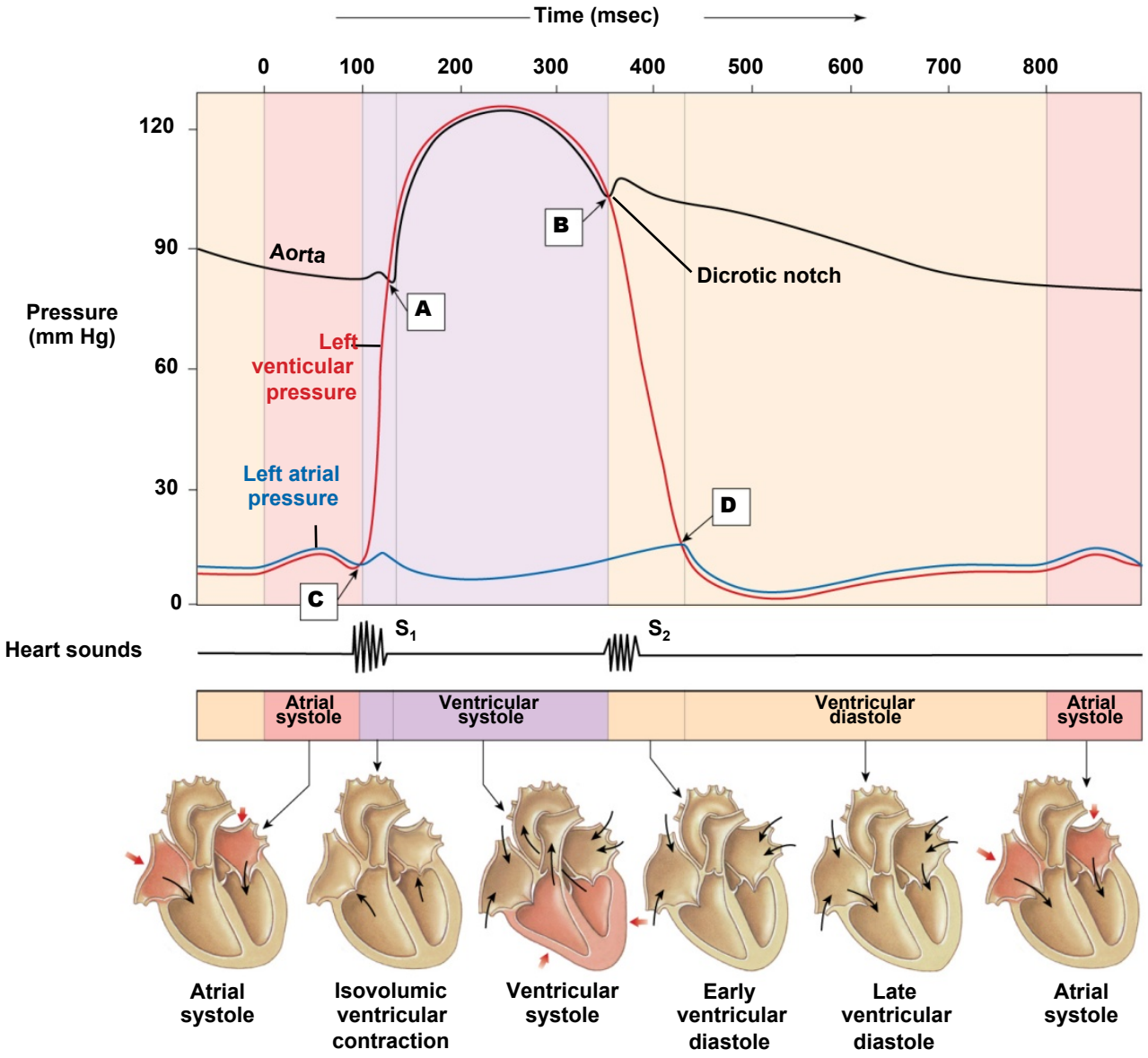
Pressure-Volume curve



Cardiac Echocardiography

https://www.youtube.com/watch?v=4vBJoWP-zBM

The Wiggers diagram



Reading

Silverthorn 5th edition:

Chapter 14, pp. 468-507