

Cardiovascular System & Its Diseases

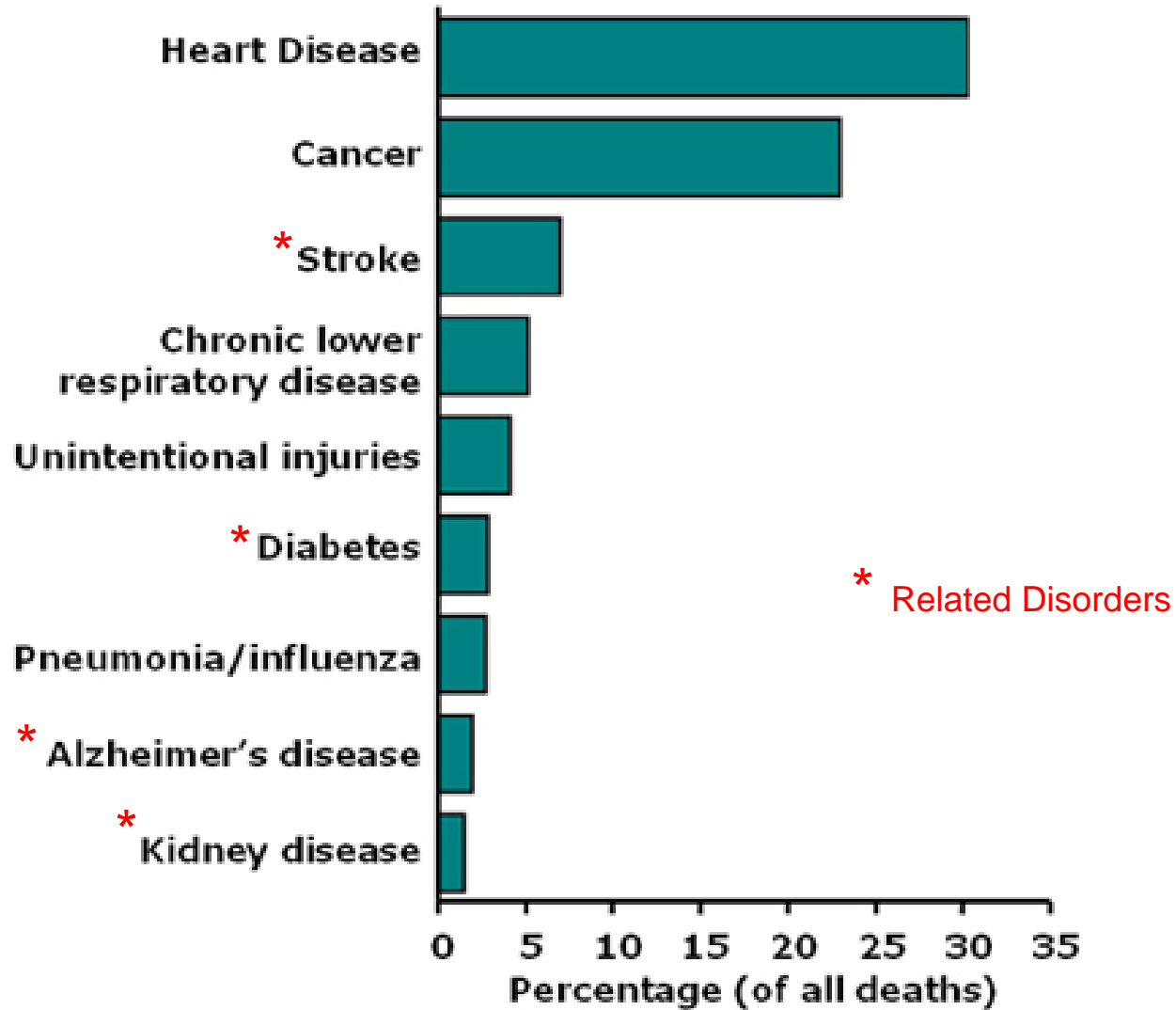
Lecture #1

Cardiovascular System

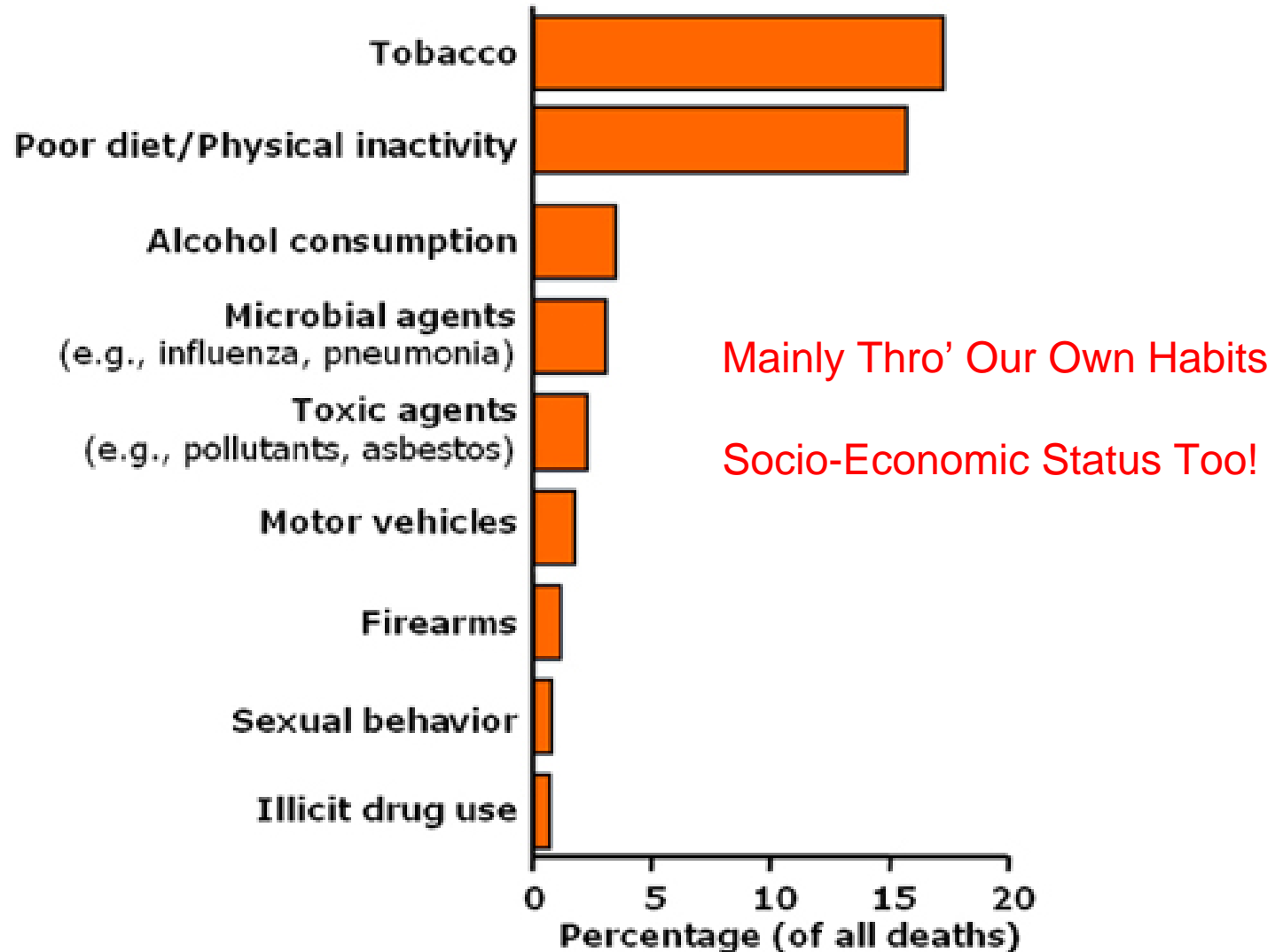


*Dr. Derek Bowie,
Department of Pharmacology & Therapeutics,
Room 1317, McIntyre Bldg, McGill University
derek.bowie@mcgill.ca*

Leading Causes of Death United States, 2000



Actual Causes of Death[†] United States, 2000



Overview of Lecture Series

1. Cardiovascular System

Bits 'N' Pieces

Blood, Heart, Blood-Vessels

Keeping It Under Control

Heart Rate, Blood Pressure

When Things Go Wrong

Hypertension, Ischemia, Heart Failure, Arrhythmias

2. Hypertension

Aetiology

Diagnosis

Treatment

Sympathoplegic Drugs, Diuretics, Vasodilators, Angiotensin Antagonists

3. Myocardial Ischemia

Aetiology

Diagnosis

Treatment

Symptomatic: Nitrites, Calcium Channel Blockers, β -Blockers

Prophylactic: Lipid lowering, Anti-coagulant, Anti-platelet drugs

4. Heart Failure & Cardiac Arrhythmias

Aetiology

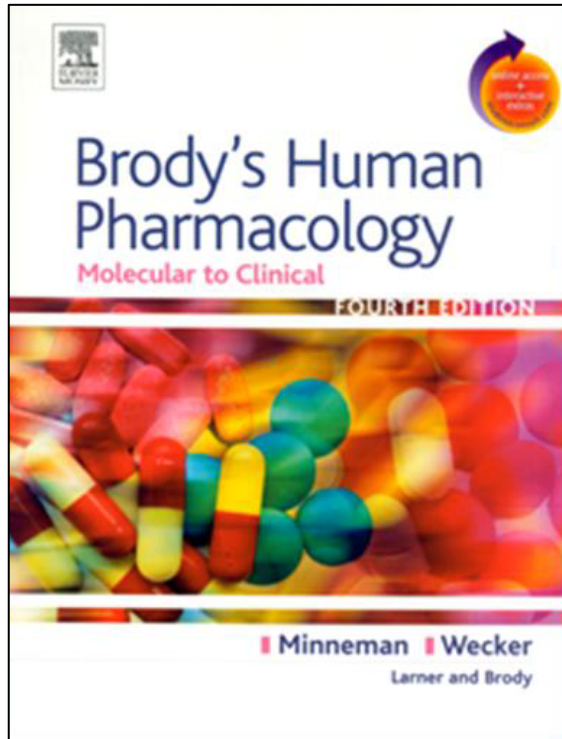
Diagnosis

Treatment

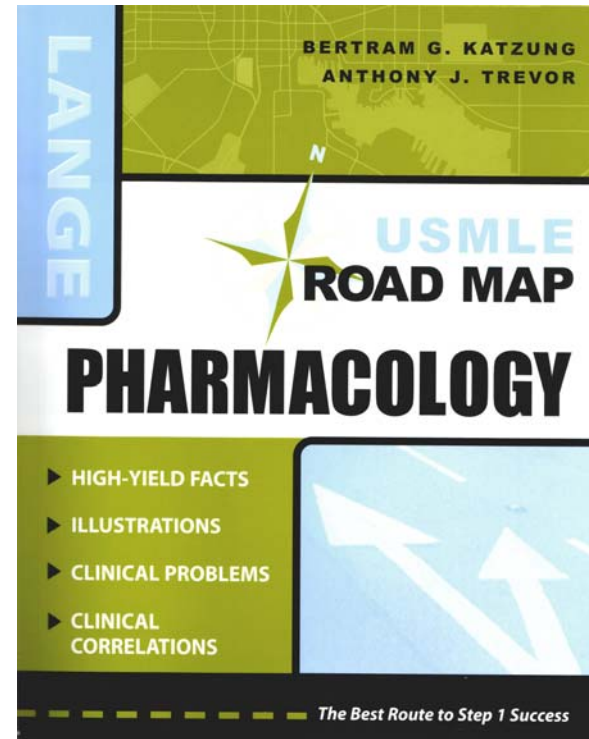
Heart Failure: Nitrites, Calcium Channel Blockers, Diuretics, Angiotensin Antagonists, β -Blockers, β -Receptor Agonist, Cardiac Glycosides

Arrhythmias: Channel Blockers (Groups I – IV), Miscellaneous

What To Read?



Chapters 8 -19



Chapters 2 - 3

What Will You Learn Today?

Don't Put the Cart Before The Horse
Physiology Then Pharmacology



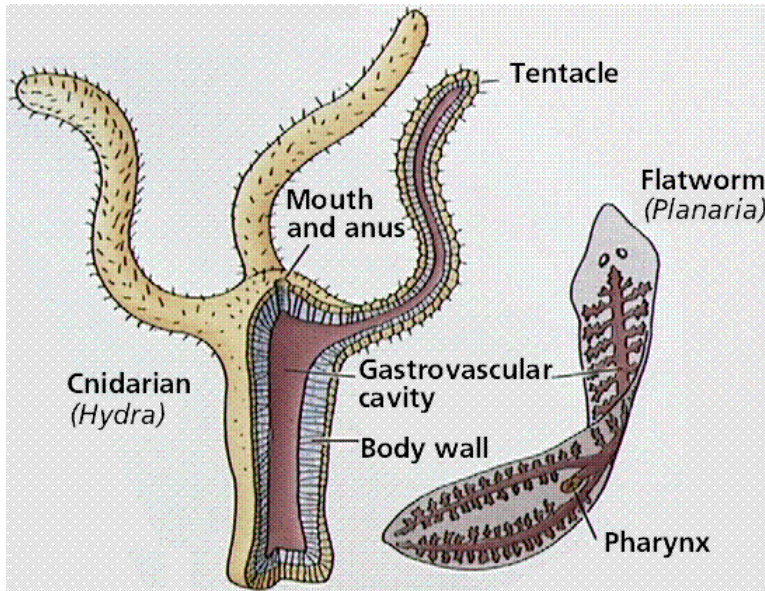
"It says here you can lead
a horse to water . . ."

1. Components of the CV System: Blood, Heart & Blood Vessels
2. Regulation: Heart Rate, Blood Pressure (Autonomic NS) & Pharmacology
3. Playing Doctor: Mystery Case !!!!!!!!!!!!!!!!

1. Components of the CV System

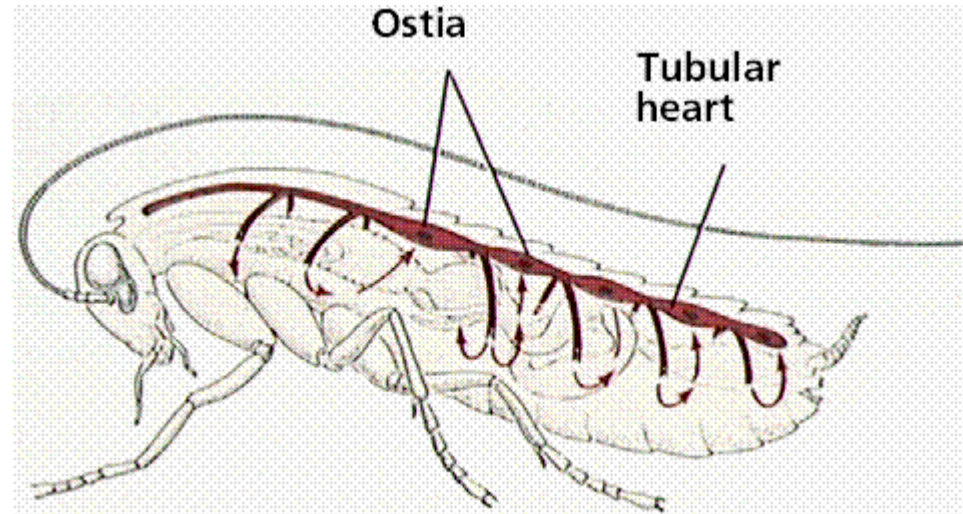
Simple System

(single-celled organisms use their surface for nutrient and gaseous exchange)



Open Circulatory System

(common to molluscs and arthropods; blood bathes tissues with flow being sluggish)

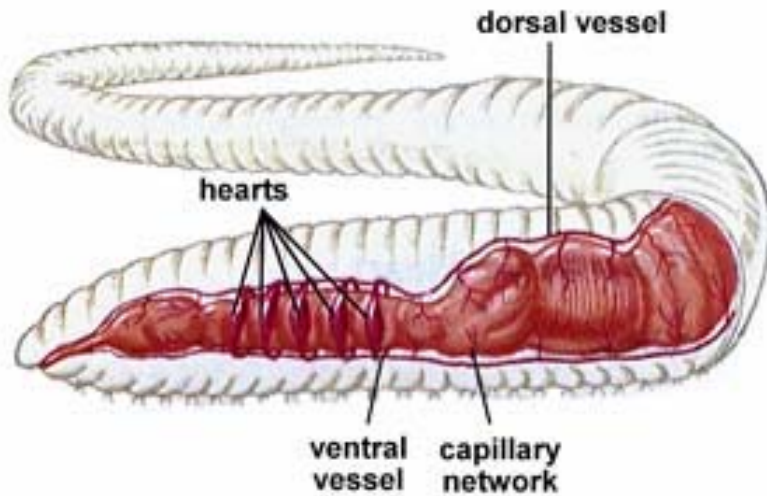


There are different types of Circulatory Systems

1. Components of the CV System

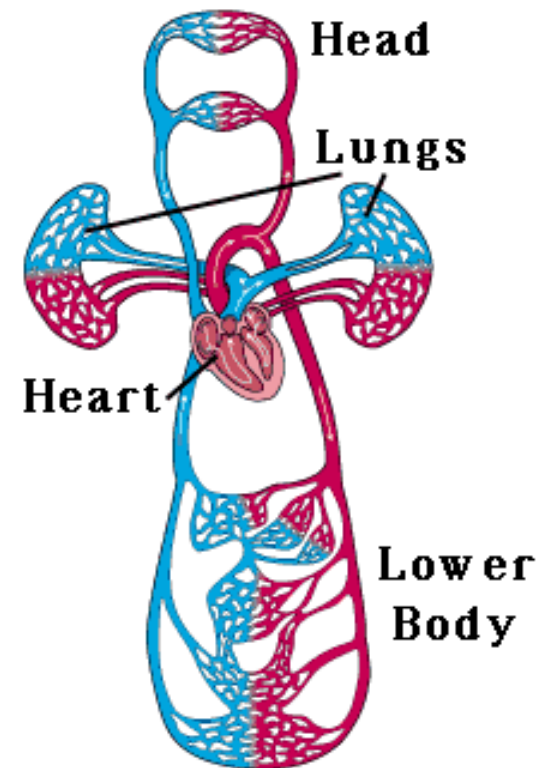
Closed Circulatory System

(in echinoderms and vertebrates; blood enclosed in specialized vessels)

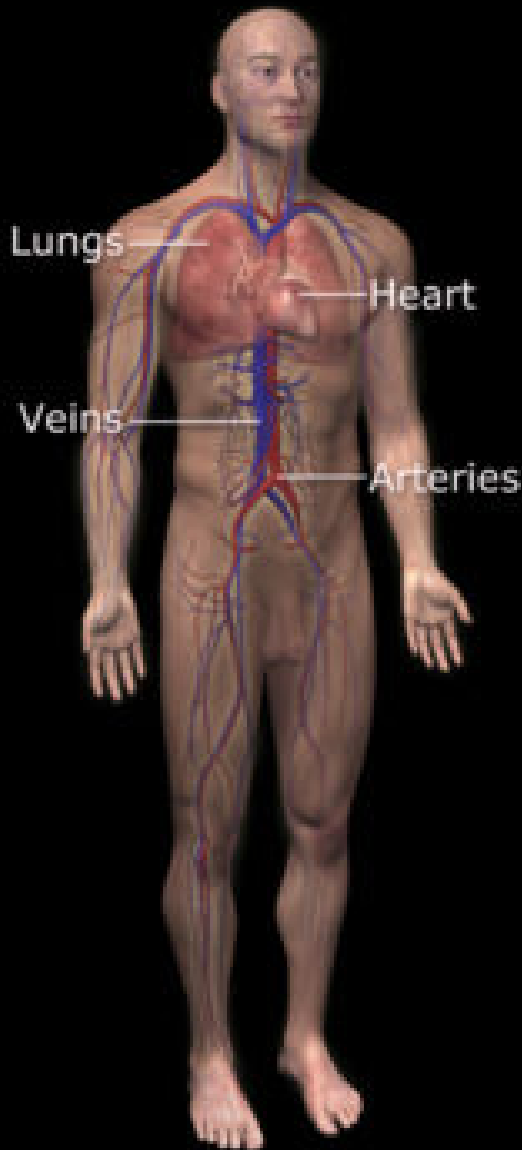


Vertebrate Cardiovascular System

(multi-chambered heart with complex valves; blood transported in vessels)



A Little Bit of History



Fish:

Single (2-chambers) circulatory system (gills to rest of body)

Amphibians / Reptiles:

Double (sometimes 3-chambers though)

Birds / Mammals:

Complete separation (4-chambers)

4th Century BC:

Herophilus distinguished arteries from veins (blood collects in veins at death and empties from arteries; therefore, postulated arteries carried air)

2nd Century AD:

Galen assigned different functions to veins and arteries

1242:

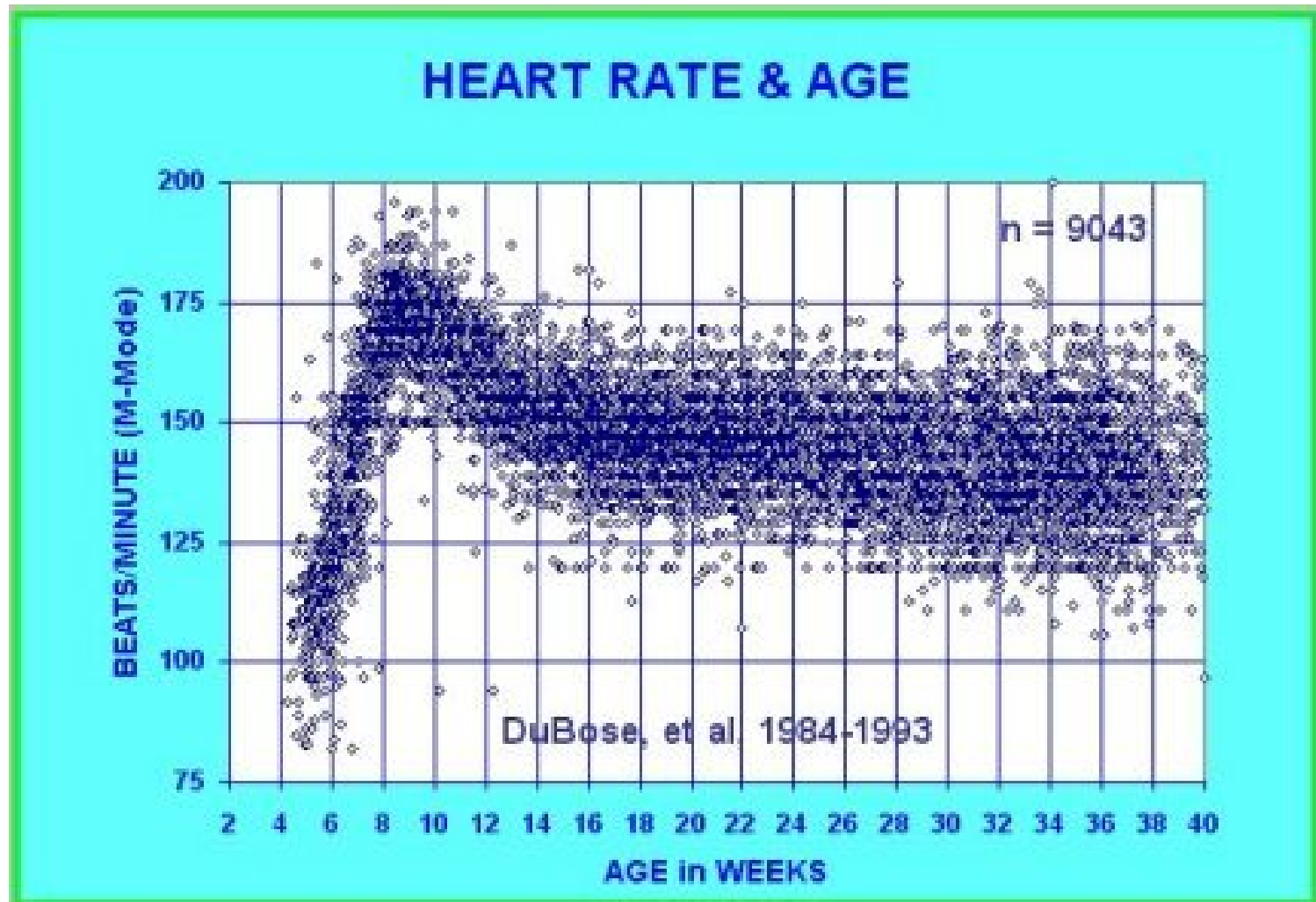
Ibn Nafis first to describe blood circulation in body

1628:

William Harvey described circulatory system in influential book but failed to identify the capillaries

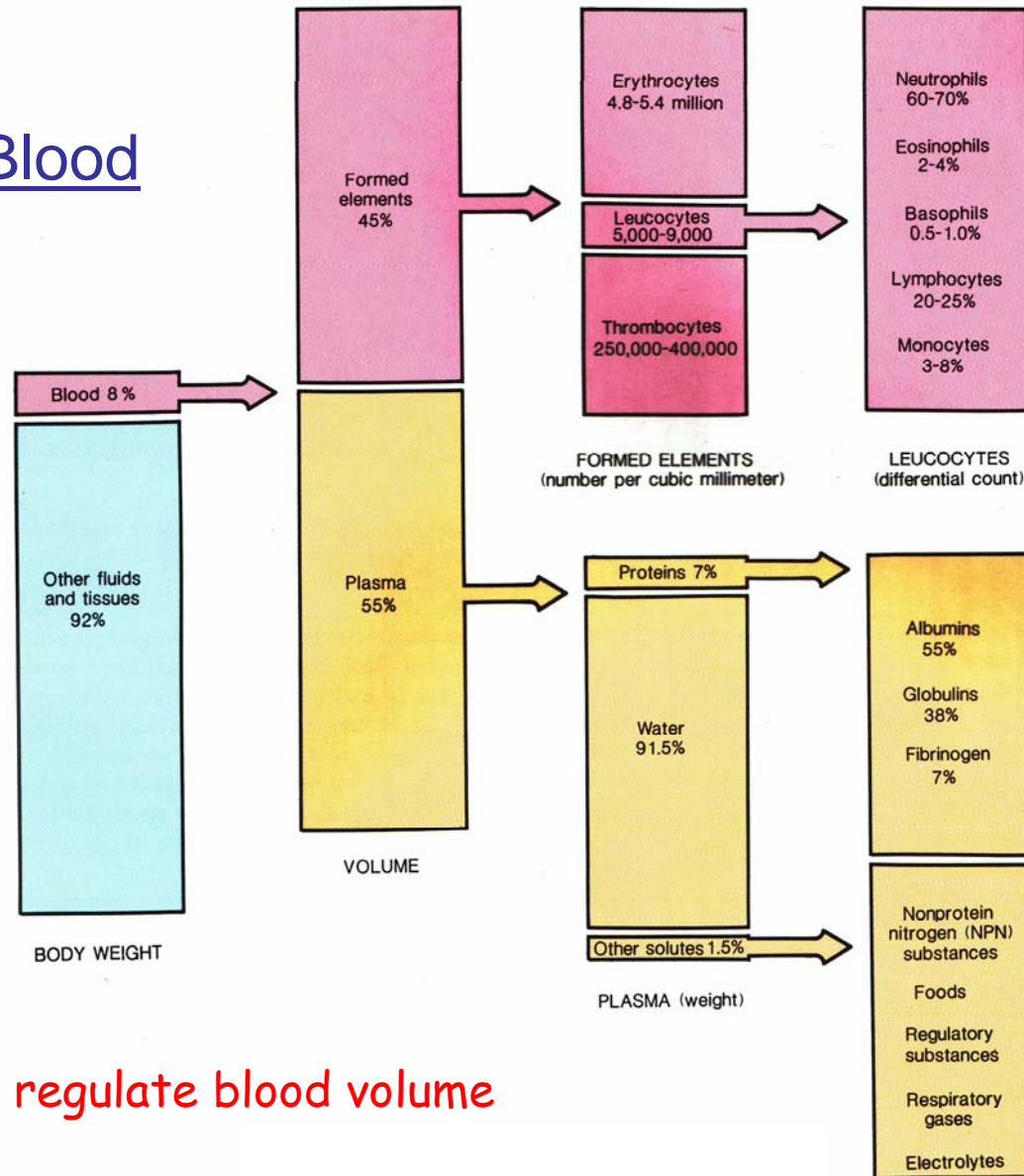
Heart Rate During Embryonic Development

Heart is one of the first organs to appear during development



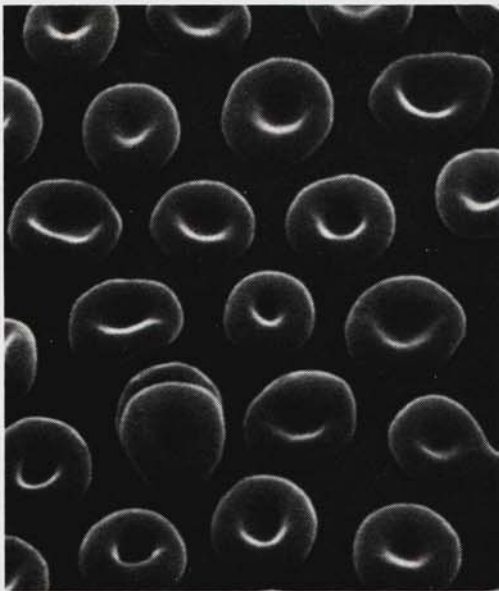
(i) Blood

Components Of Blood

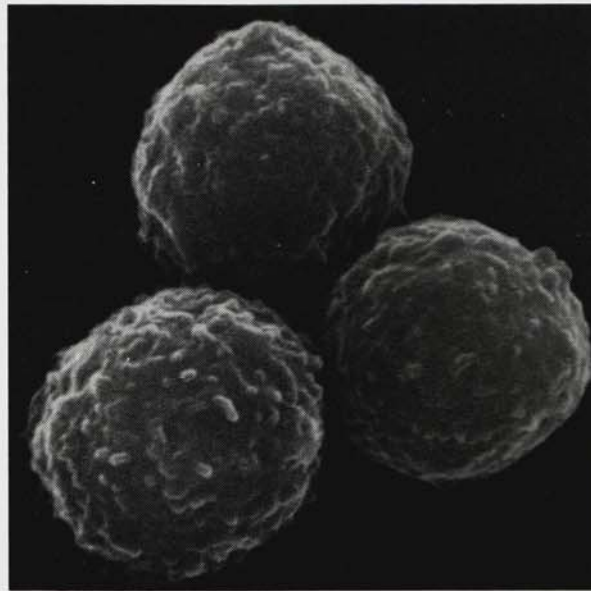


Some antihypertensives regulate blood volume

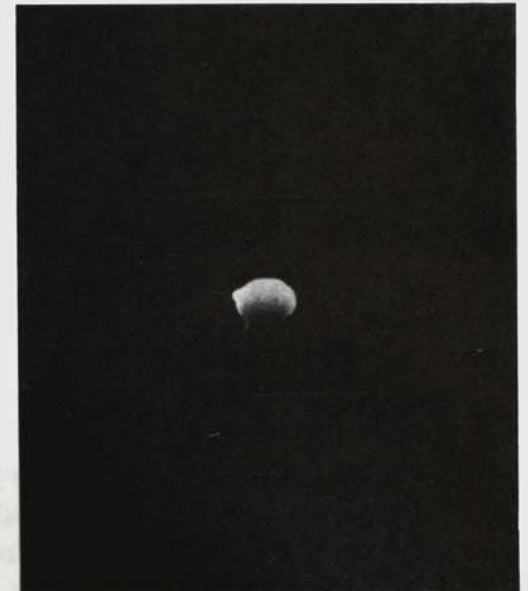
Cellular Components Of Blood



Red blood cells



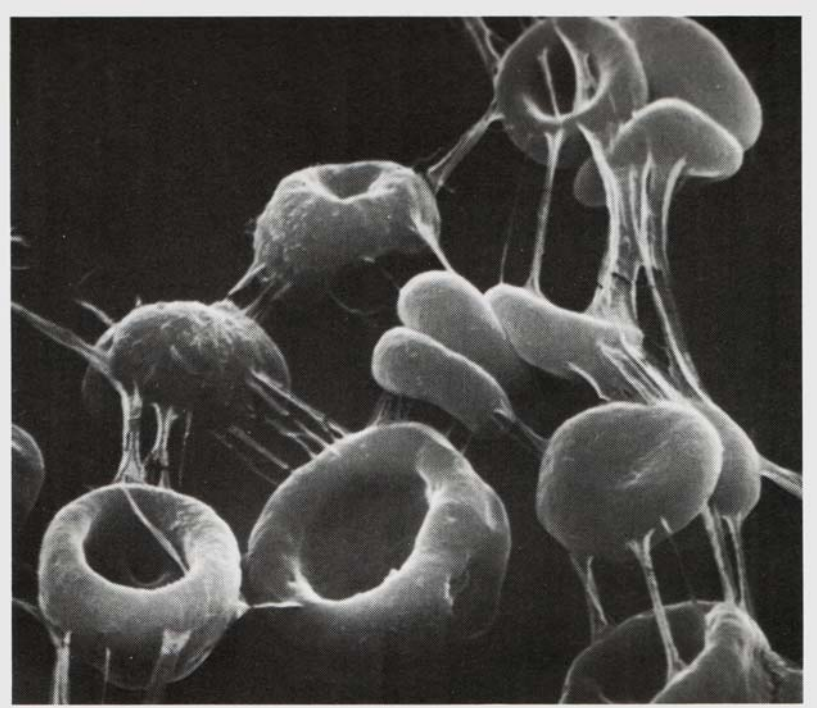
Leucocytes



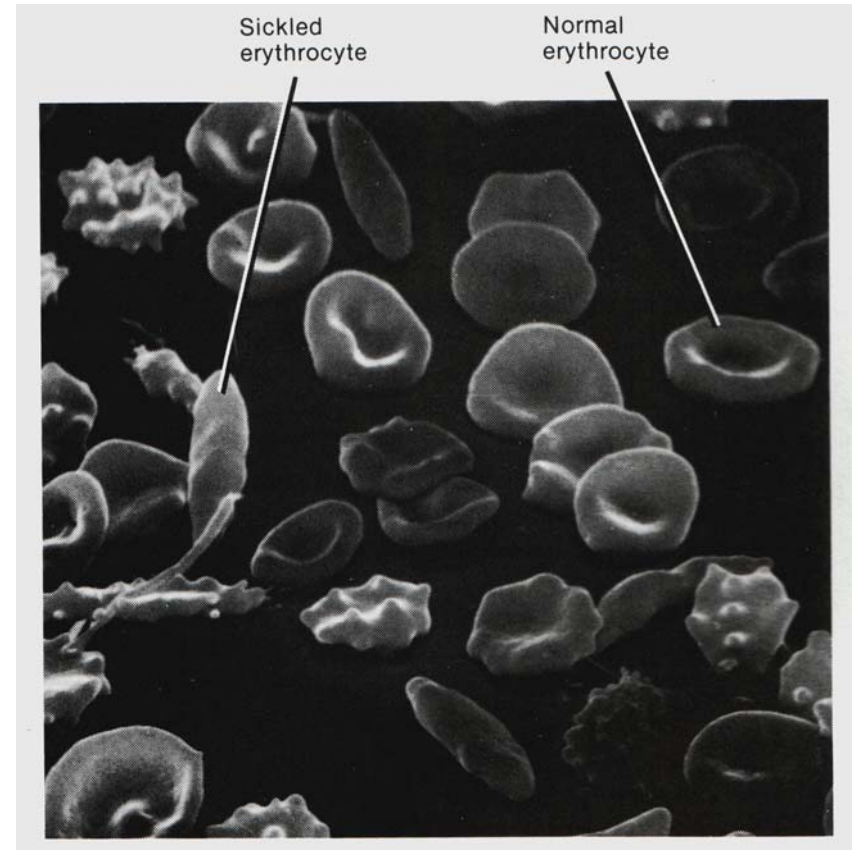
Platelet

Anticoagulants are used to prevent further blood vessel occlusion

Dynamic Nature Of RBCs

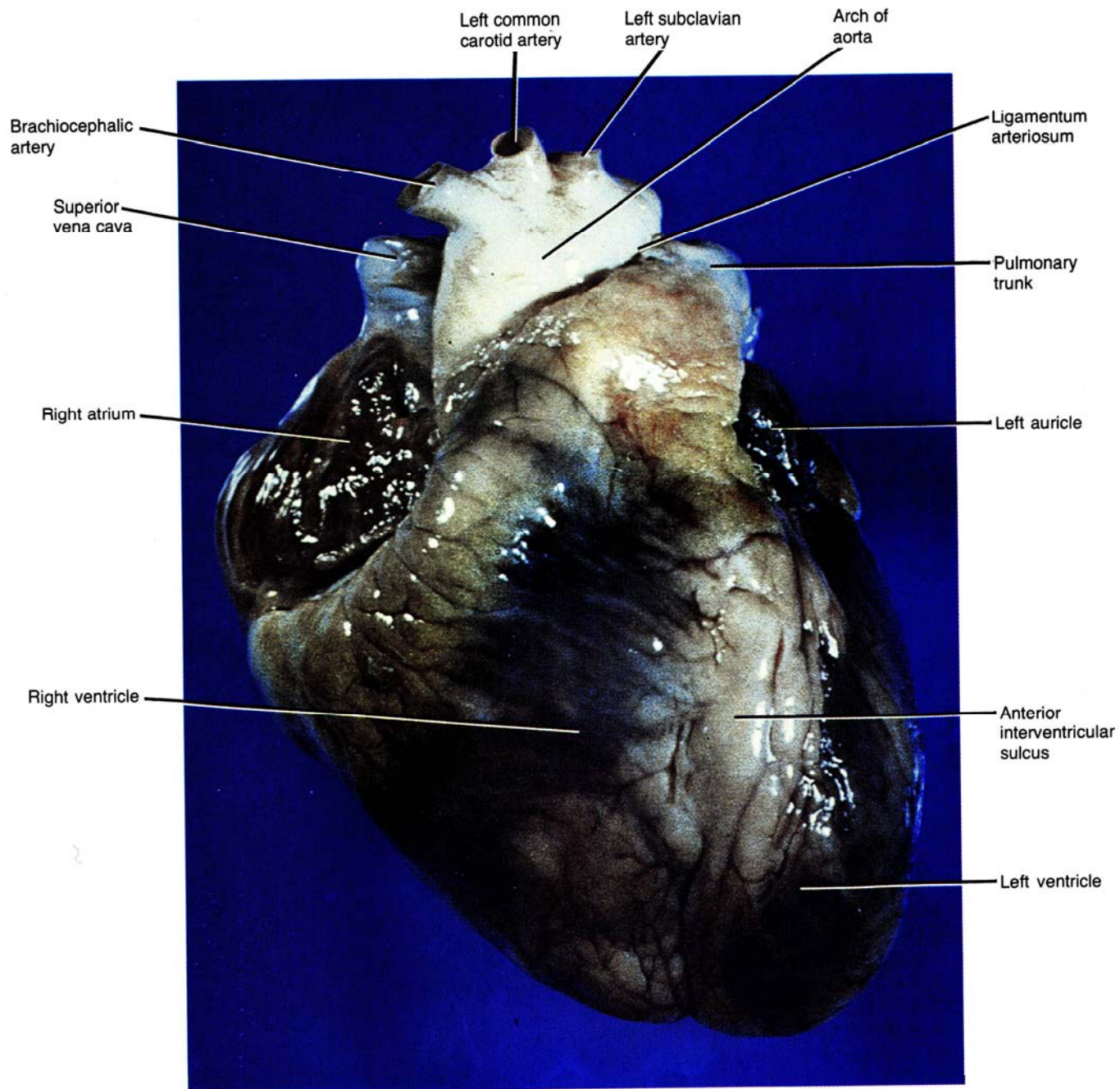


Blood Clotting

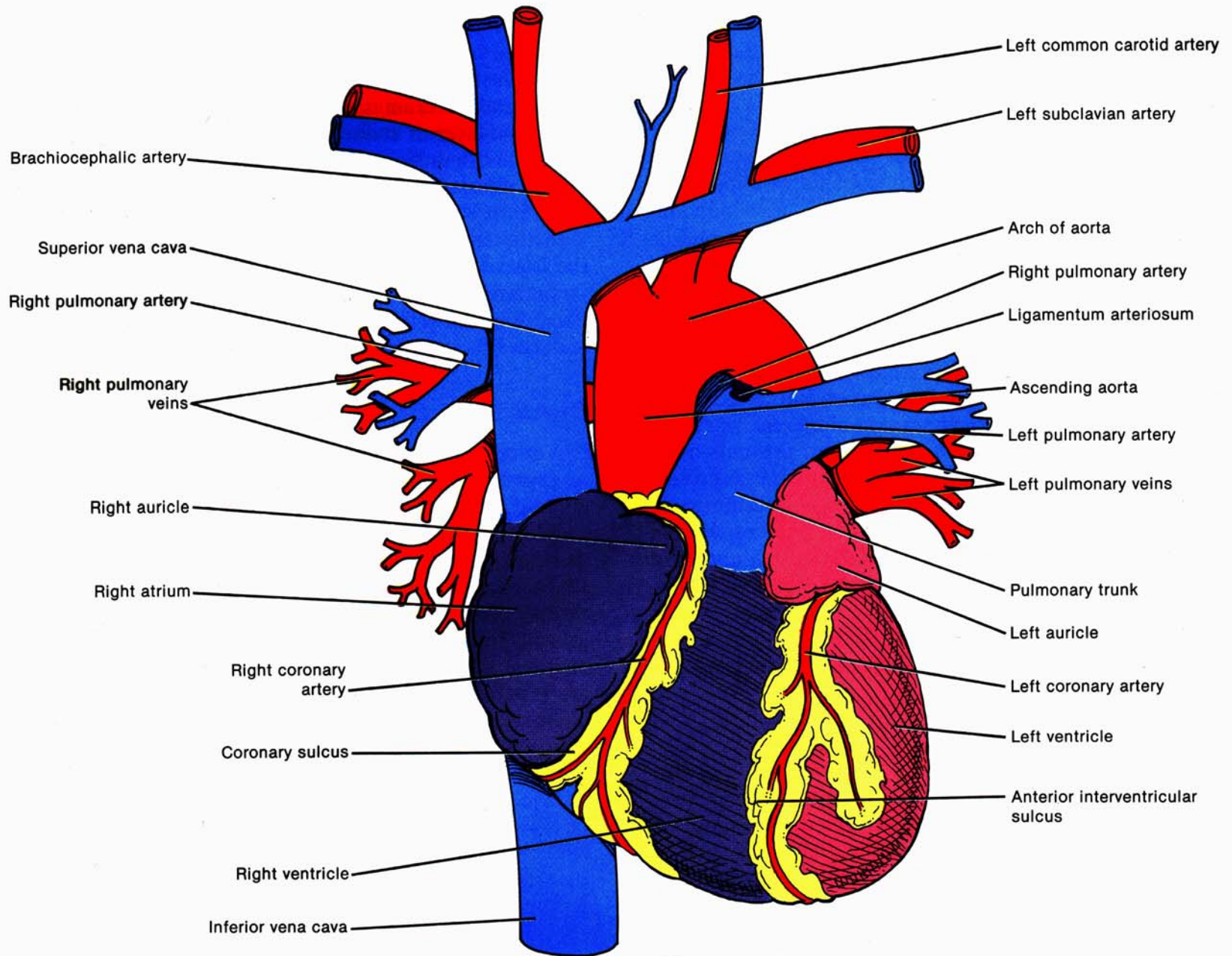


Sickle Cell anaemia

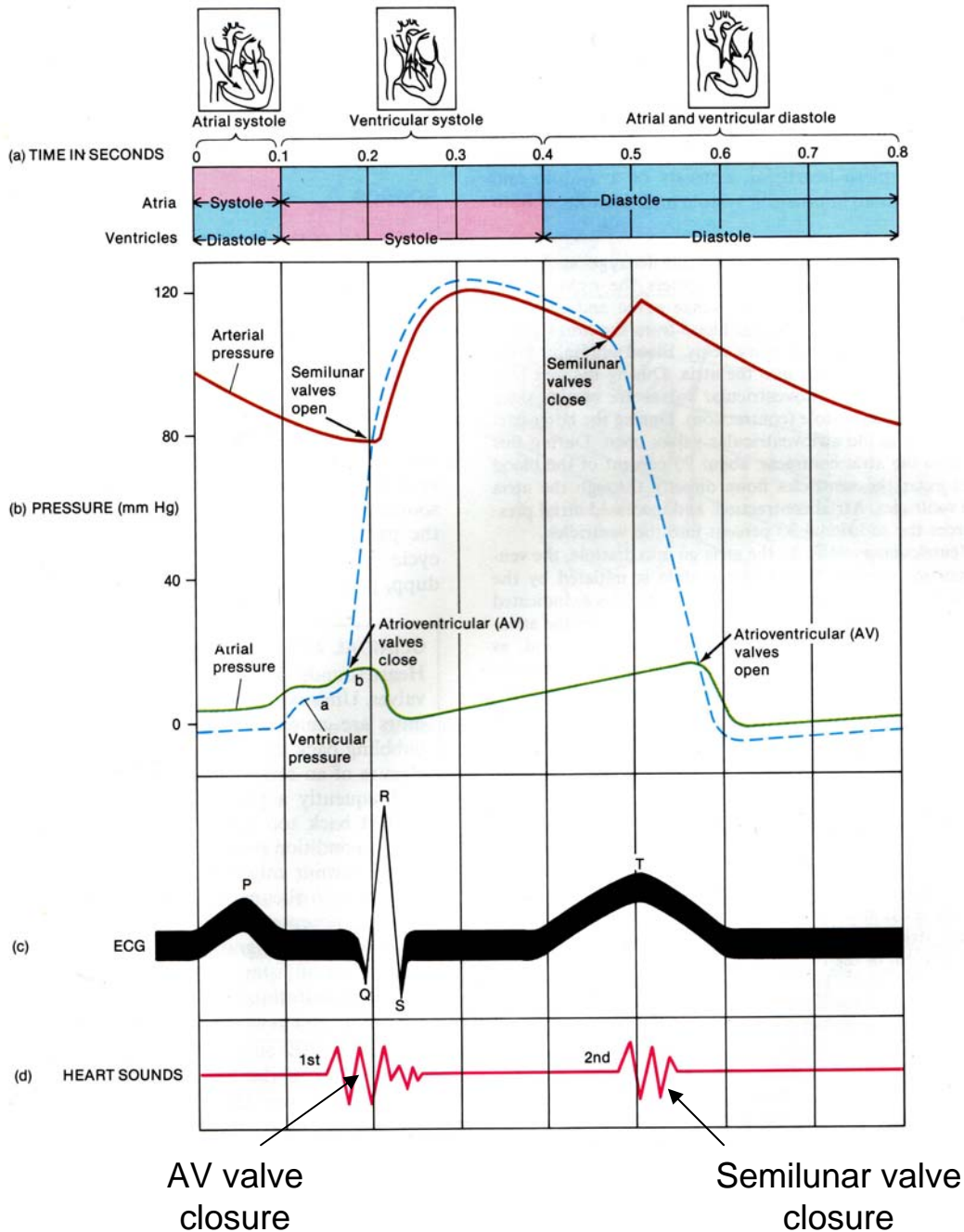
(ii) Heart



(b)



(a)



Cardiac Cycle

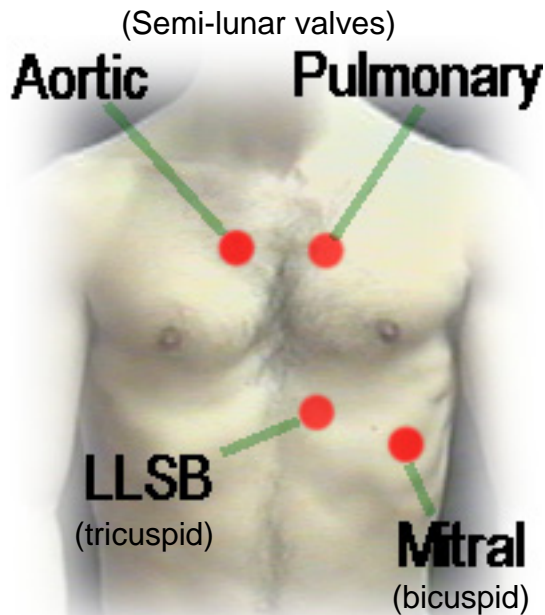
P_{wave} Atrial Depolarization

QRS_{complex} Ventricular depolarization

T_{wave} Ventricular Repolarization

NB Atrial repolarization is masked by QRS_{complex}

*** In hypertension arterial pressure is elevated which compromises the ability of the ventricles to pump effectively ***



Determining Normal Heart Behavior

[Adult Heart](#) [Link](#)

[Foetal Heart](#) [Link](#)

Normal functioning heart consists of pairs of sounds. Each pair, lub-dub, lub-dub begins with the 1st sound and ends with the 2nd. The major audible components are related to mitral, tricuspid and semi-lunar valve closure.

Early Systolic Murmur

Early systolic murmurs begin with the first sound and peak in the first third of systole. Early murmurs have the greatest intensity in the early part of the cycle. Common causes are a small ventricular septal defect (VSD), or the innocent murmurs of childhood. This recording is an **early systolic murmur** from a 20 year-old female with a small muscular VSD. [Link](#)

MidSystolic Murmur

A **midsystolic murmur** begins shortly after the first sound, peaks in the middle of systole, and does not quite extend to the second sound. It is also known as **ejection murmur**. The most characteristic feature of this murmur is its cessation before the second sound, thus leaving this latter sound identifiable as a discrete entity. This type of murmur is commonly heard in normal individuals, particularly in the young who usually have increased blood volumes flowing over normal valves.

[Link](#)

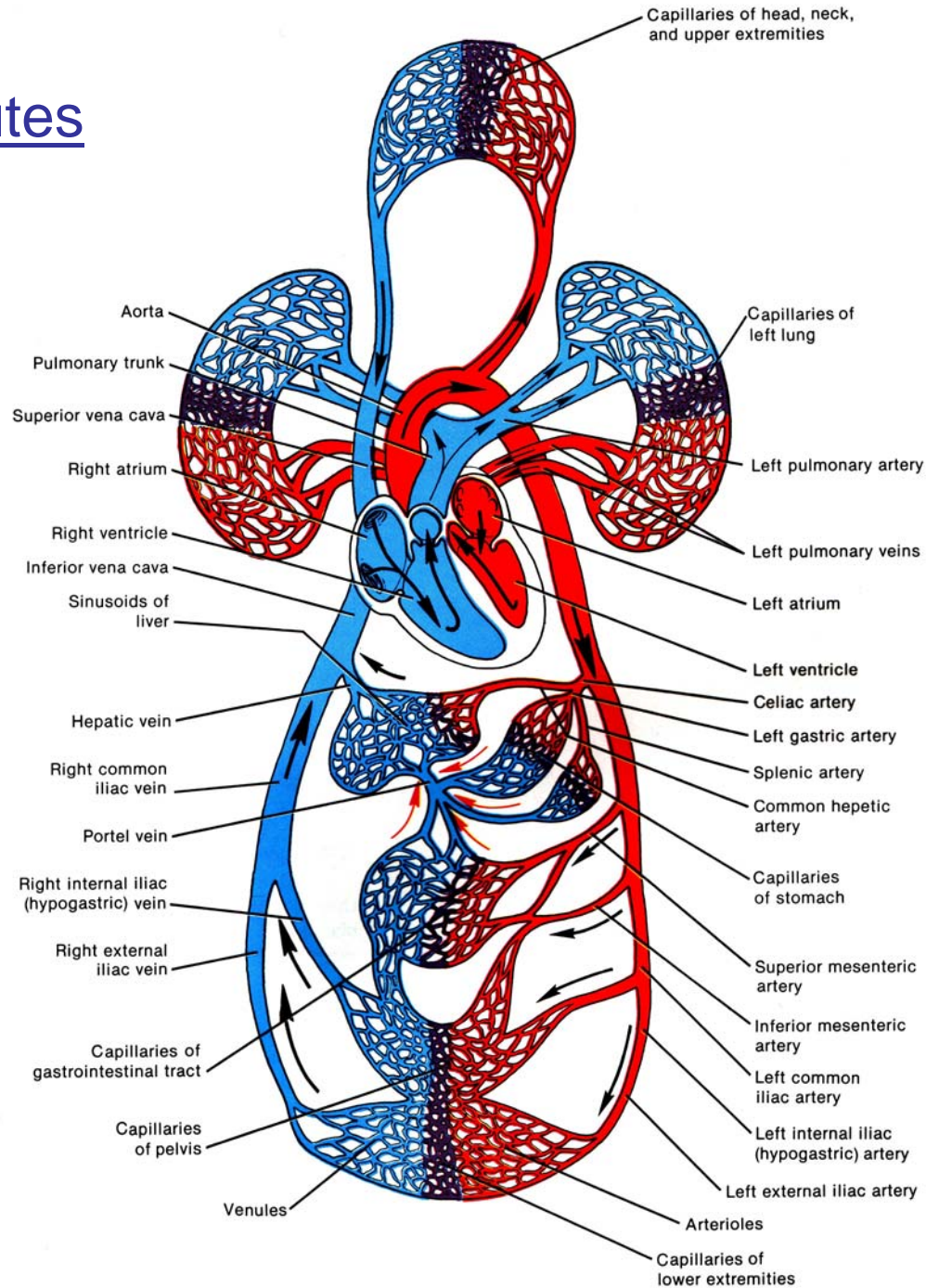
Continuous Murmur

A **pan diastolic murmur** begins with the second sound and extends throughout the diastolic period. **Patent ductus arteriosus (PDA)** is a classical example of this murmur. This condition is usually corrected in childhood. It is heard best at base left and has both a systolic and diastolic component. It is known as a **continuous murmur**.

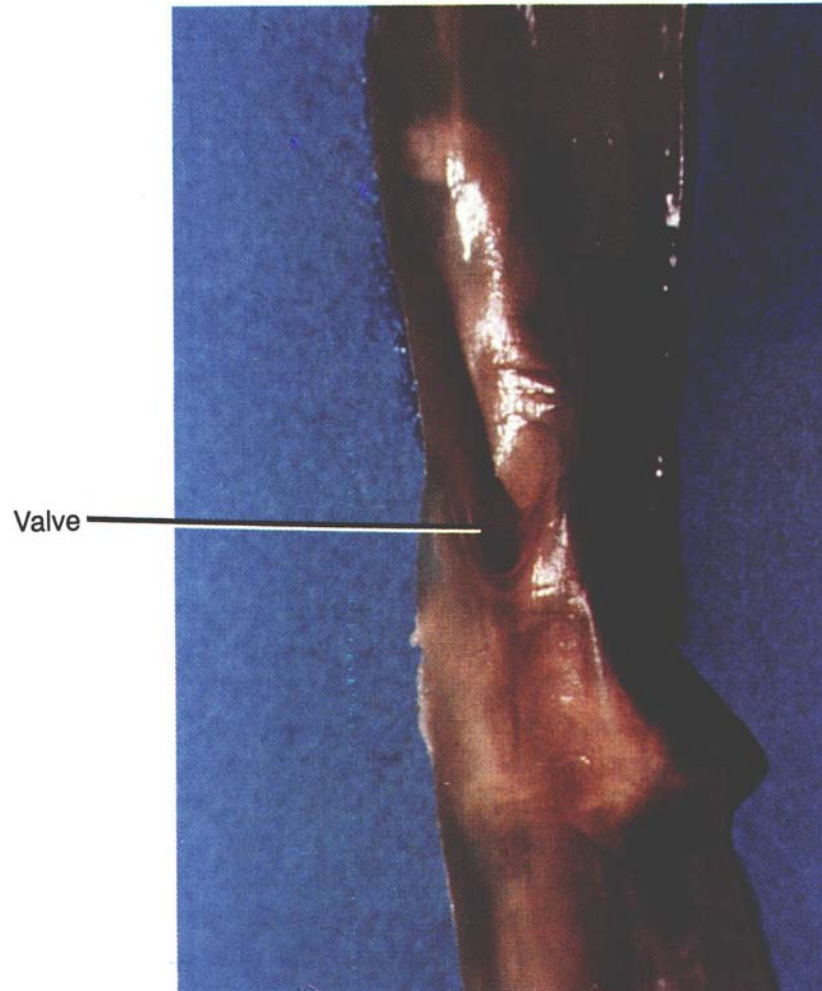
[Link](#)

(iii) Blood Vessels

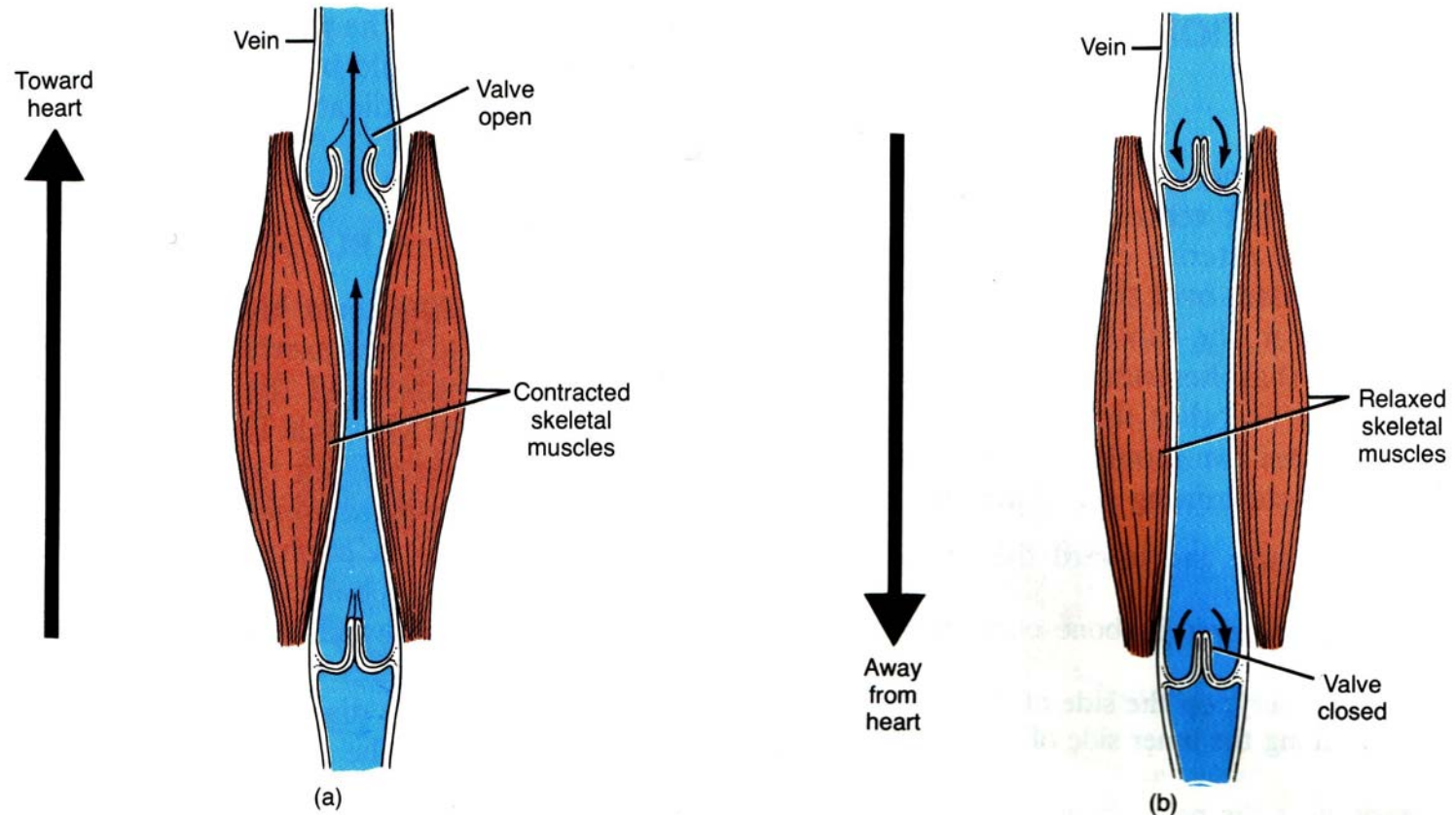
Circulatory Routes



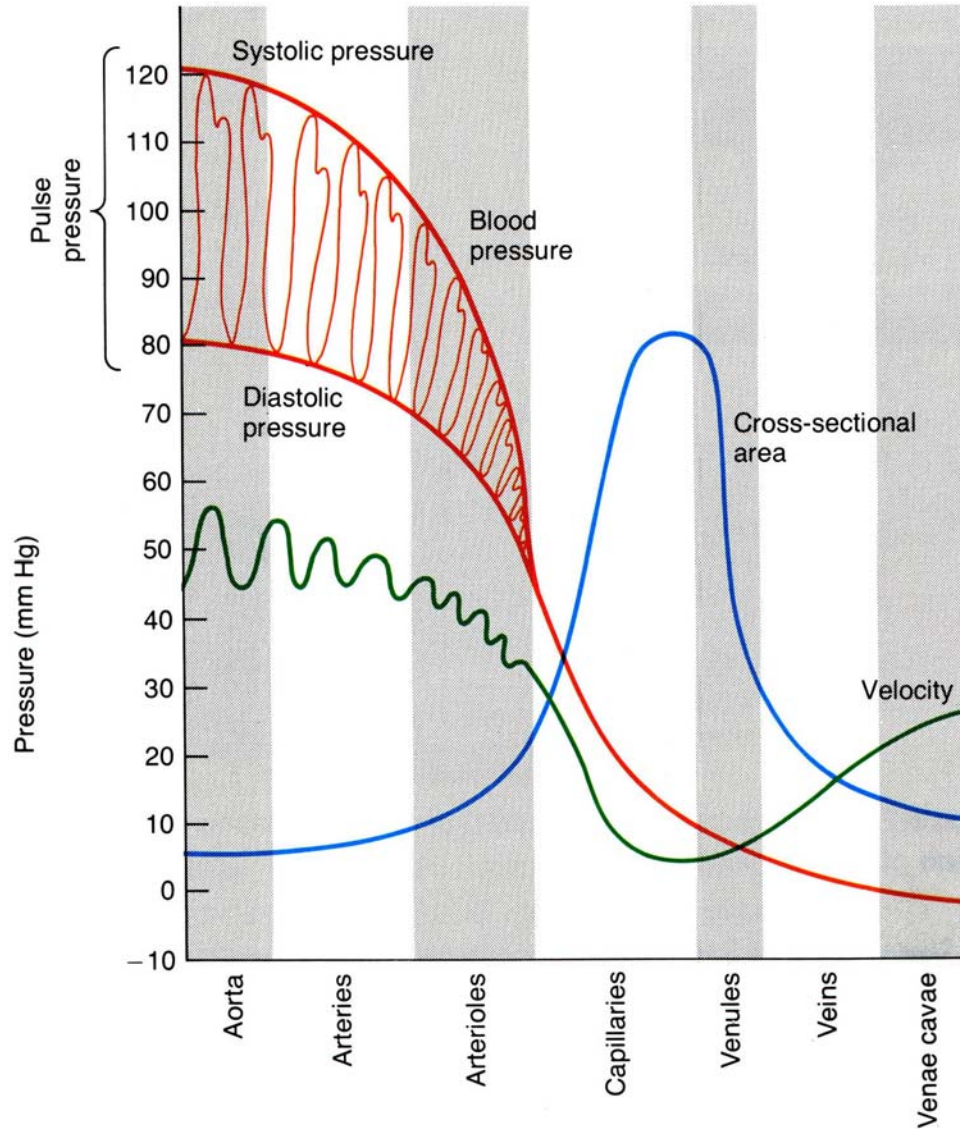
One-Way Valve In A Vein

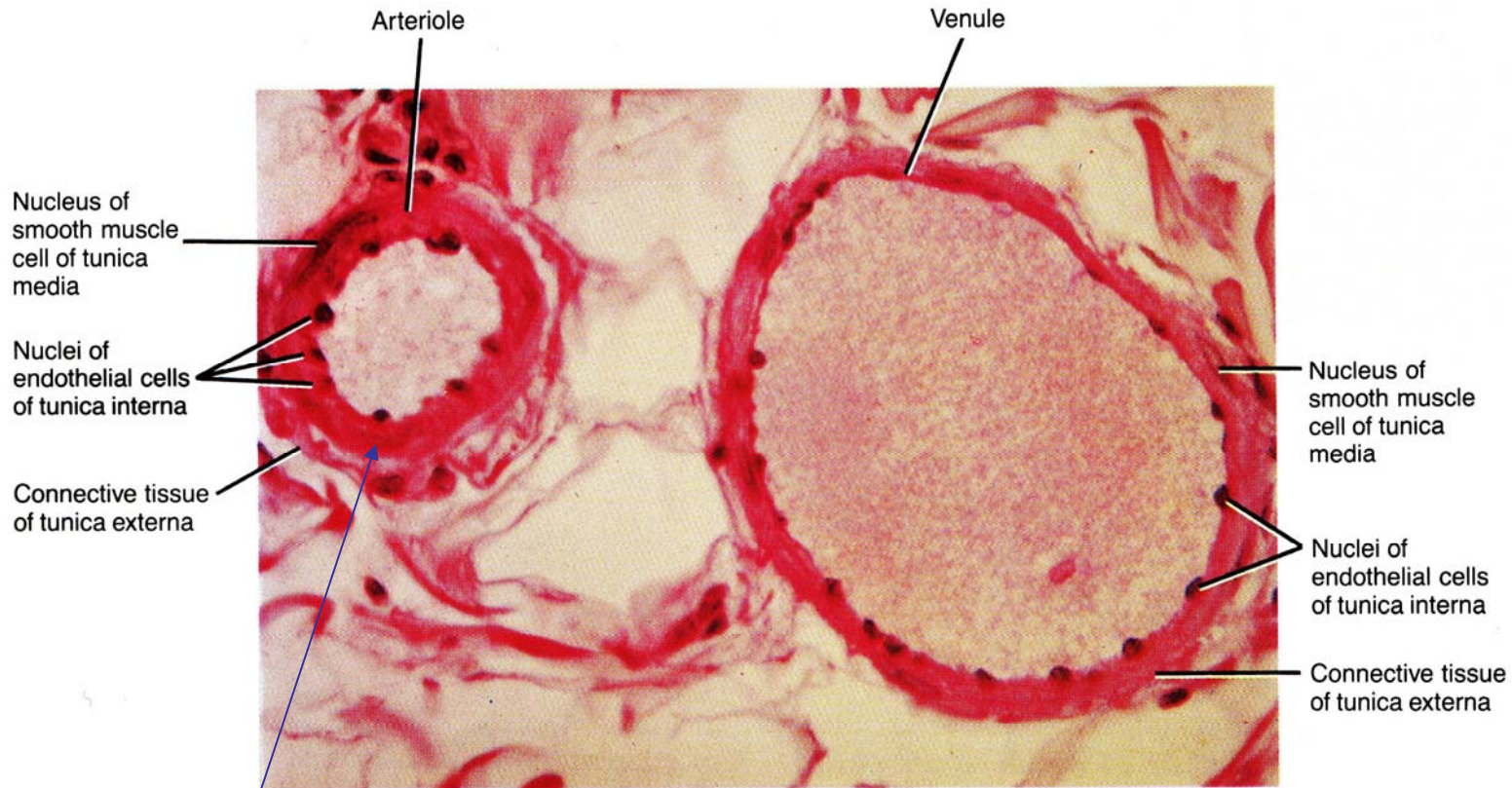


Skeletal Muscle Aids Returning Blood To The Heart



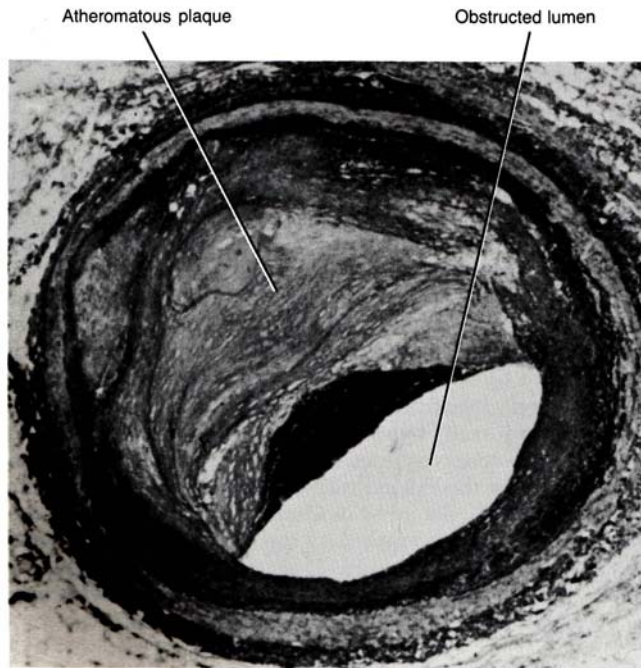
Hemodynamic Properties Of Blood Vessels



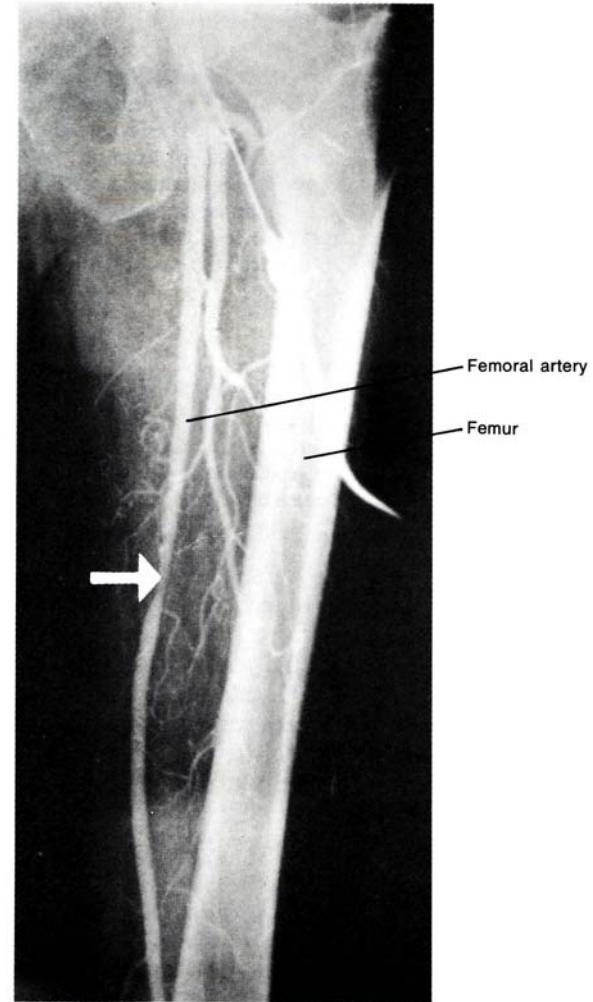


Contractility is regulated
by drugs

Atherosclerosis Restricts Blood Flow In Vessels



Can lead to claudication
(leg pain due to poor circulation)

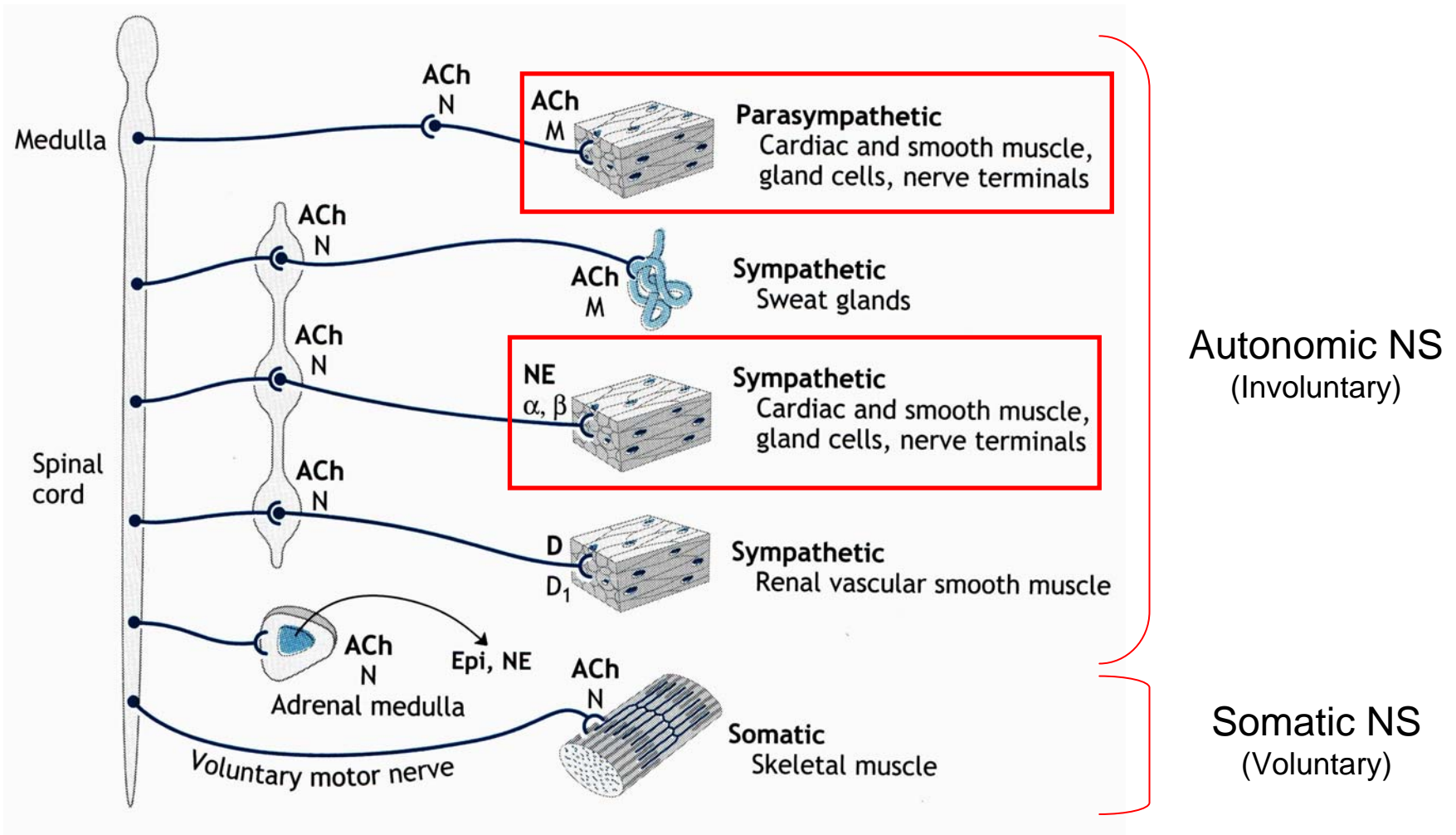


Regulating Heart Rate

2 Things To Remember:

Cardiac Pacemaker Activity & the Autonomic NS

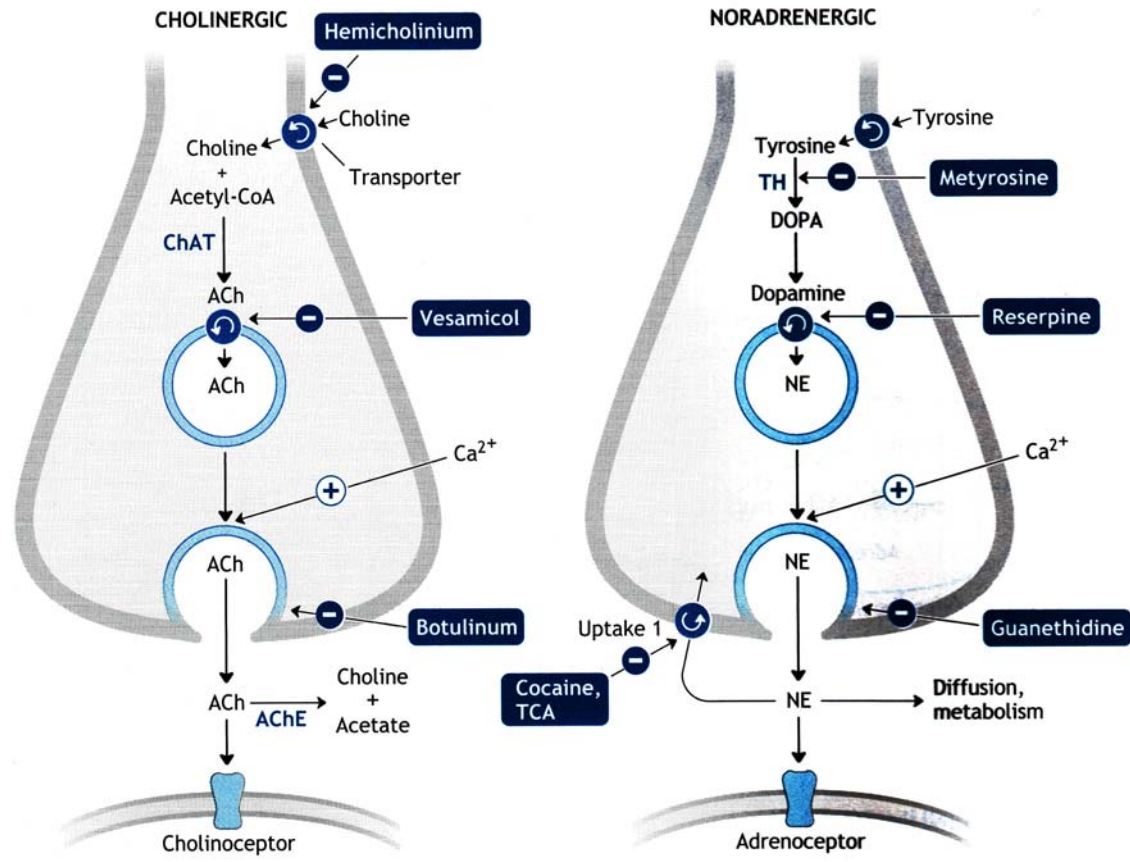
What Is The Autonomic Nervous System?



Sympathetic & Parasympathetic NS Have Opposing Actions On The Heart

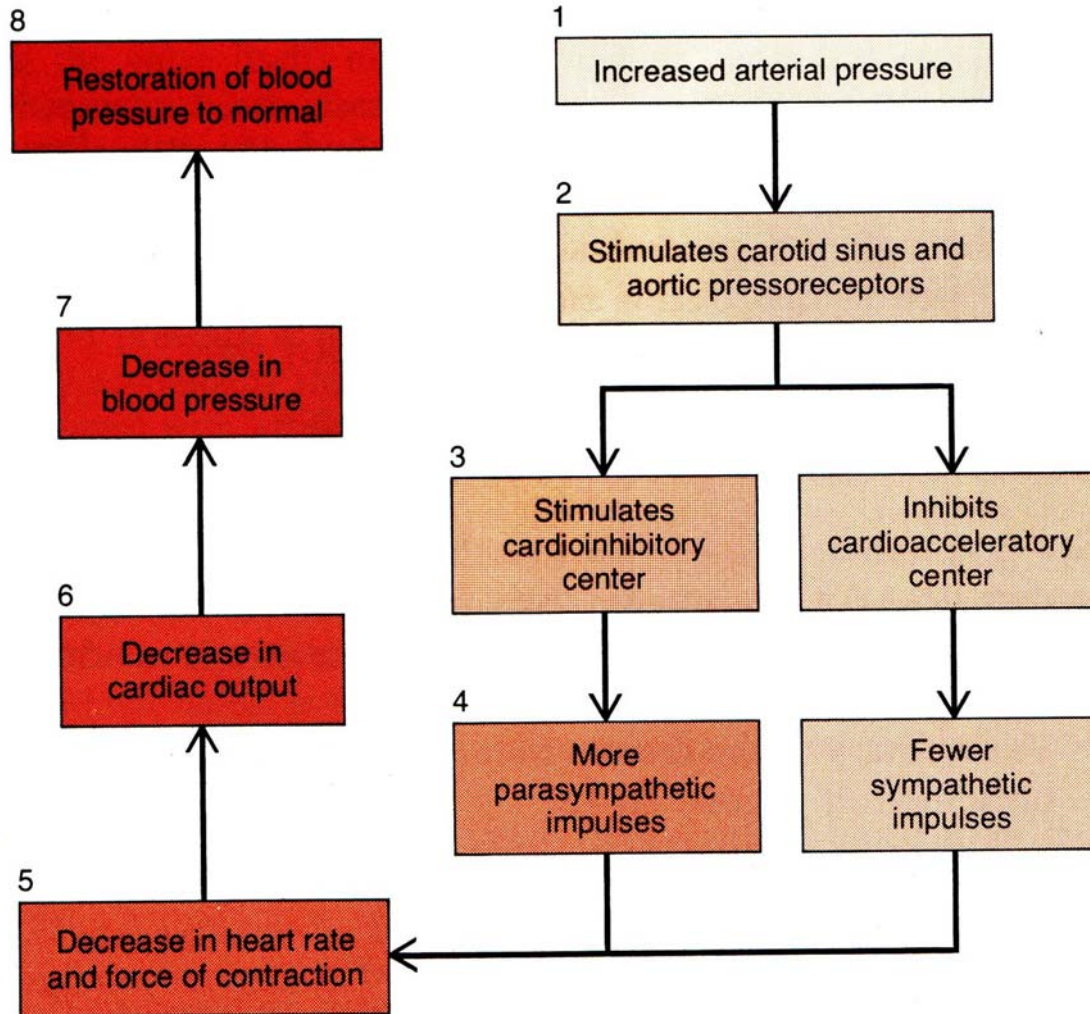
Transmitter	Receptor Type	G Protein	Location	Effect and Second Messengers
Acetylcholine	Nicotinic	None	Ganglia	Opens Na ⁺ , K ⁺ channel, depolarizes cell
	Muscarinic	G _q	Smooth muscle, some glands	Increases second messengers IP ₃ and DAG
		G _i	Cardiac muscle	Decreases cAMP, opens K ⁺ channels
Norepinephrine	α ₁	G _q	Smooth muscle, some glands	Increases second messengers IP ₃ and DAG
	α ₂	G _i	Smooth muscle, preganglionic nerve endings, CNS	Decreases second messenger cAMP
	β ₁ , β ₂ , β ₃	G _s	Smooth and cardiac muscle, juxtaglomerular apparatus, adipocytes	Increases second messenger cAMP

Typical Cholinergic & Noradrenergic Nerve Endings

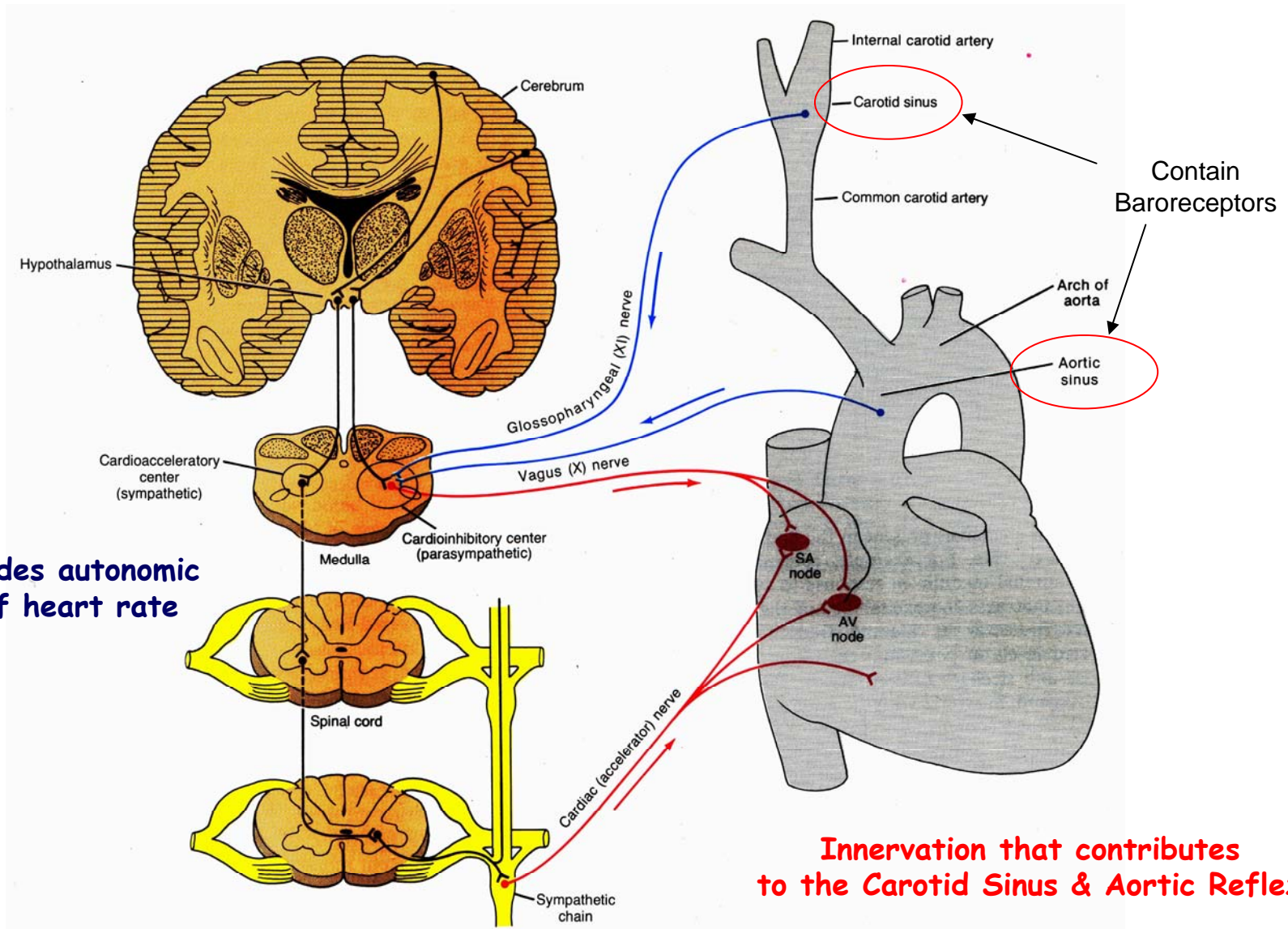


Homeostatic Regulation Of Heart Rate

Marey's Law: Inverse relationship between blood pressure & heart rate

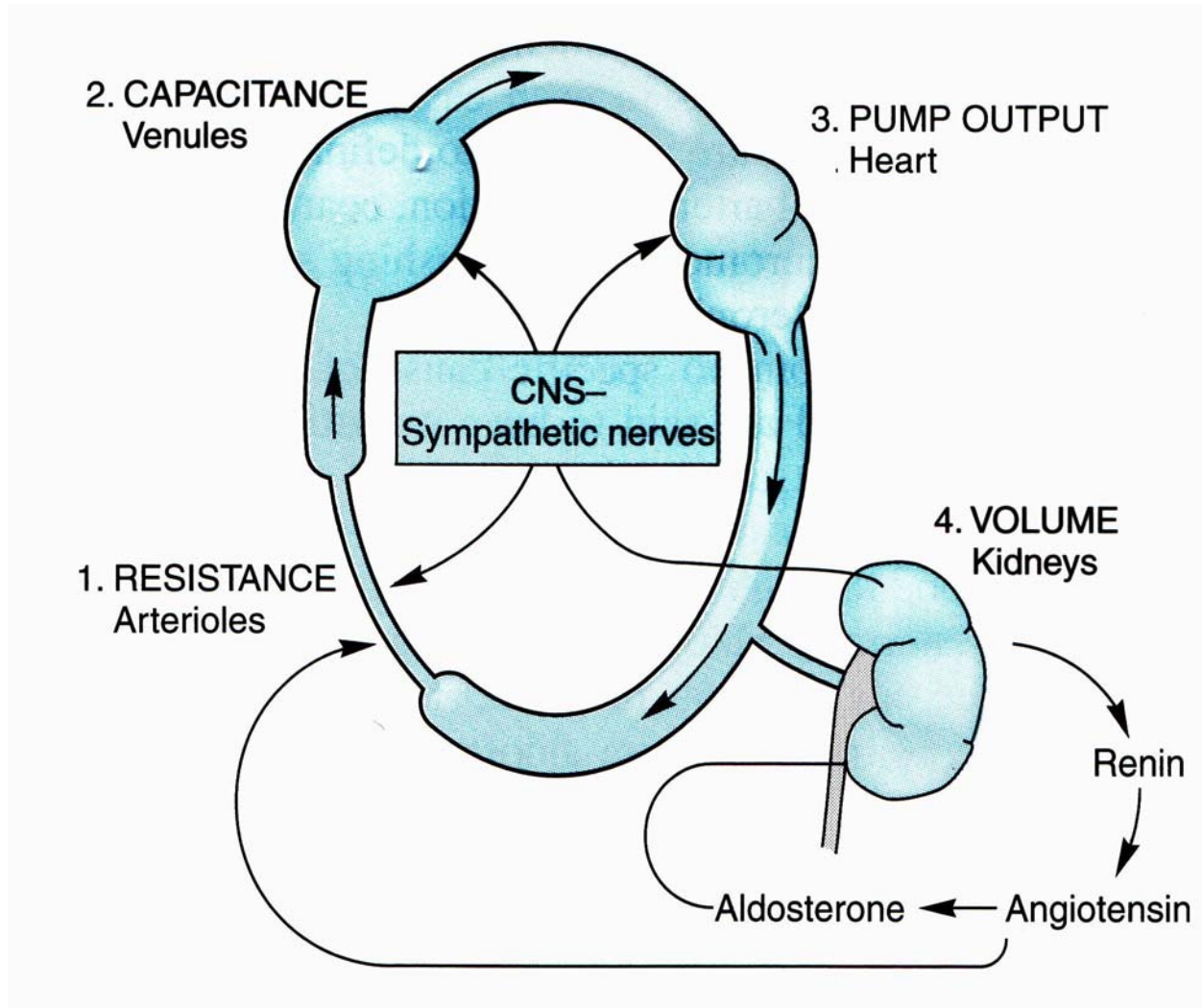


Autonomic Nervous System Regulates Heart Rate

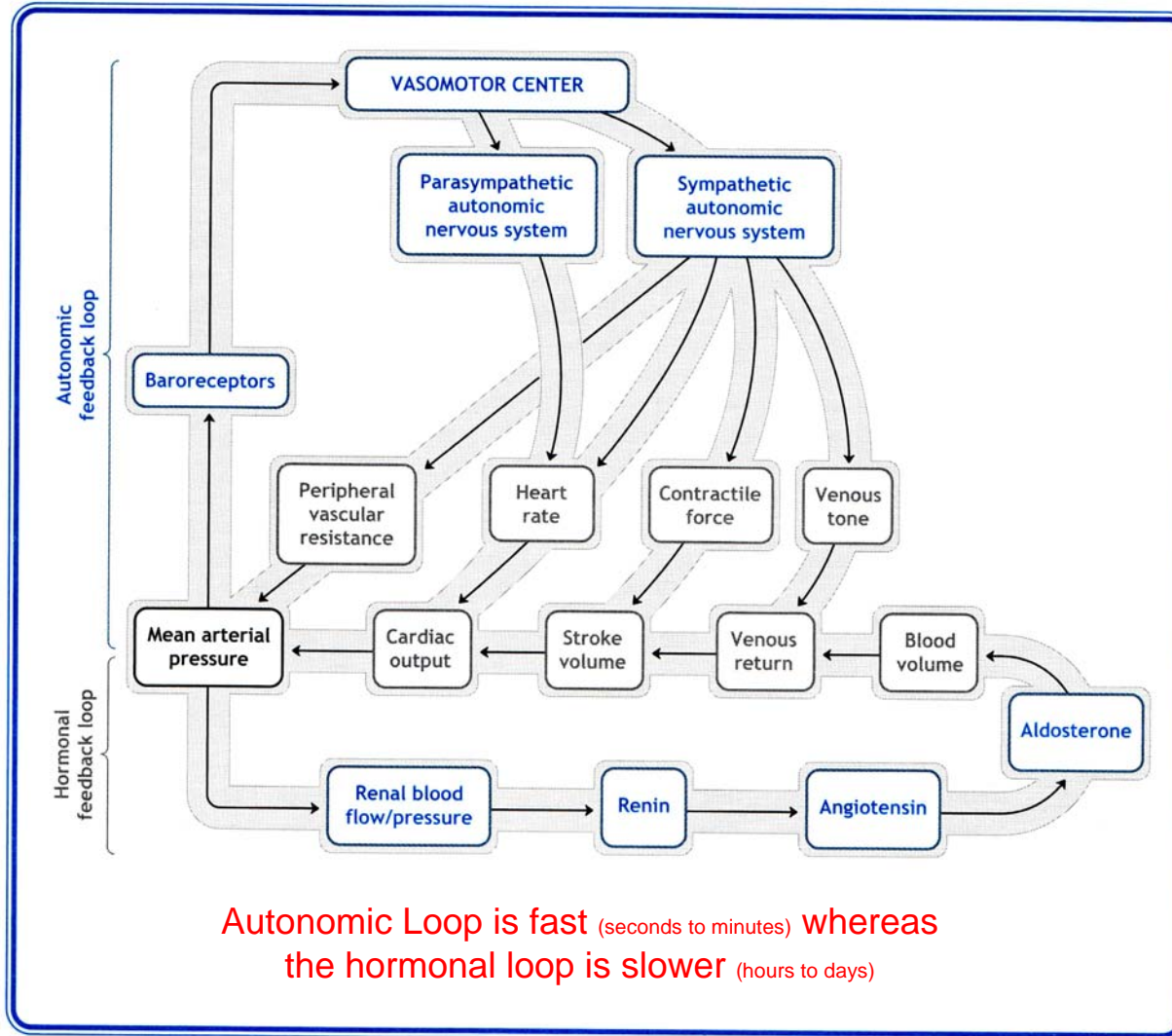


Regulating Blood Pressure

Controlling Blood Pressure At Multiple Regulatory Sites



Autonomic & Hormonal Control Of Cardiovascular Function



NAME MY DISEASE



Autonomic Nervous System

Case Study

The patient is 21 yrs old and has experienced frequent episodes of blurred vision, dizziness, faintness and syncope for as long as she can remember.

She is the only child; her mother has a history of two spontaneous abortions at 12 and 14 weeks of gestation and one stillborn child at 38 weeks. The subject had a normal development during childhood; although she was considered apathetic and she avoided physical exercise.

Is this a disorder of the Sympathetic NS,
Parasympathetic NS or Both?

Autonomic Nervous System

Case Study

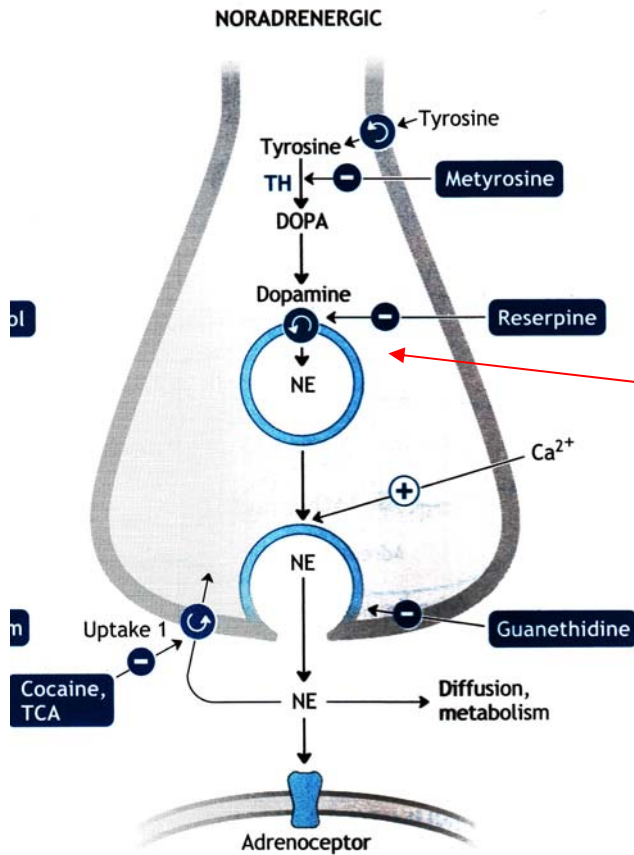
Plasma noradrenaline and adrenaline were undetectable but dopamine was 7 times normal. Upon 60° head-up tilting, noradrenaline and adrenaline did not change (in normal subjects, they increase) but dopamine increased (usually it does not).

What's wrong with this patient?

Cardiovascular System & Its Diseases:

Autonomic Nervous System

Case Study



This patient has a congenital deficiency in dopamine β -hydroxylase;

The enzyme which converts dopamine to noradrenaline.

What's Next?

Disease States



Lecture #2. **Hypertension** most common, asymptomatic

Lecture #3. **Myocardial Ischemia** demand-supply imbalance

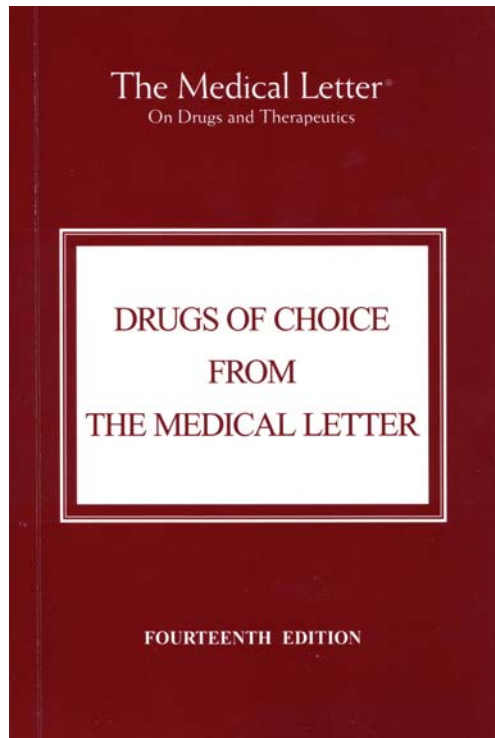
Lecture #4. **Heart Failure** multifactorial **Arrhythmias** impulse abnormality

Cardiovascular System And Its Diseases

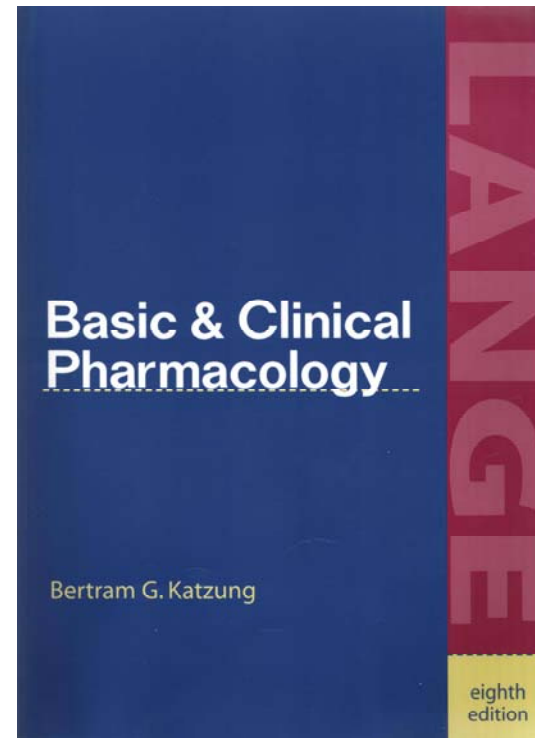
What Have We Learned?

1. Components: Blood, Heart & Blood Vessels
2. Regulation: Heart Rate & Blood Pressure
3. Diseases: Hypertension, Angina, Heart Failure & Arrhythmias

Further Reading?



Pages 56 - 64, 99 -115, 121-129



Chapters 11 - 15