

Ch 2.

Anatomy and Physiology

part 2



The Brain

▶ What is a sleeping brain's favorite musical group (rock band)?

--REM

Where does a brain go on vacation?

--Hippocampus

What did the hippocampus say during its retirement speech?

--

What do neurons use to talk to each other?

--



2. 3. TISSUES

groups of cells and surrounding substances that function together to perform one or more specialized activities

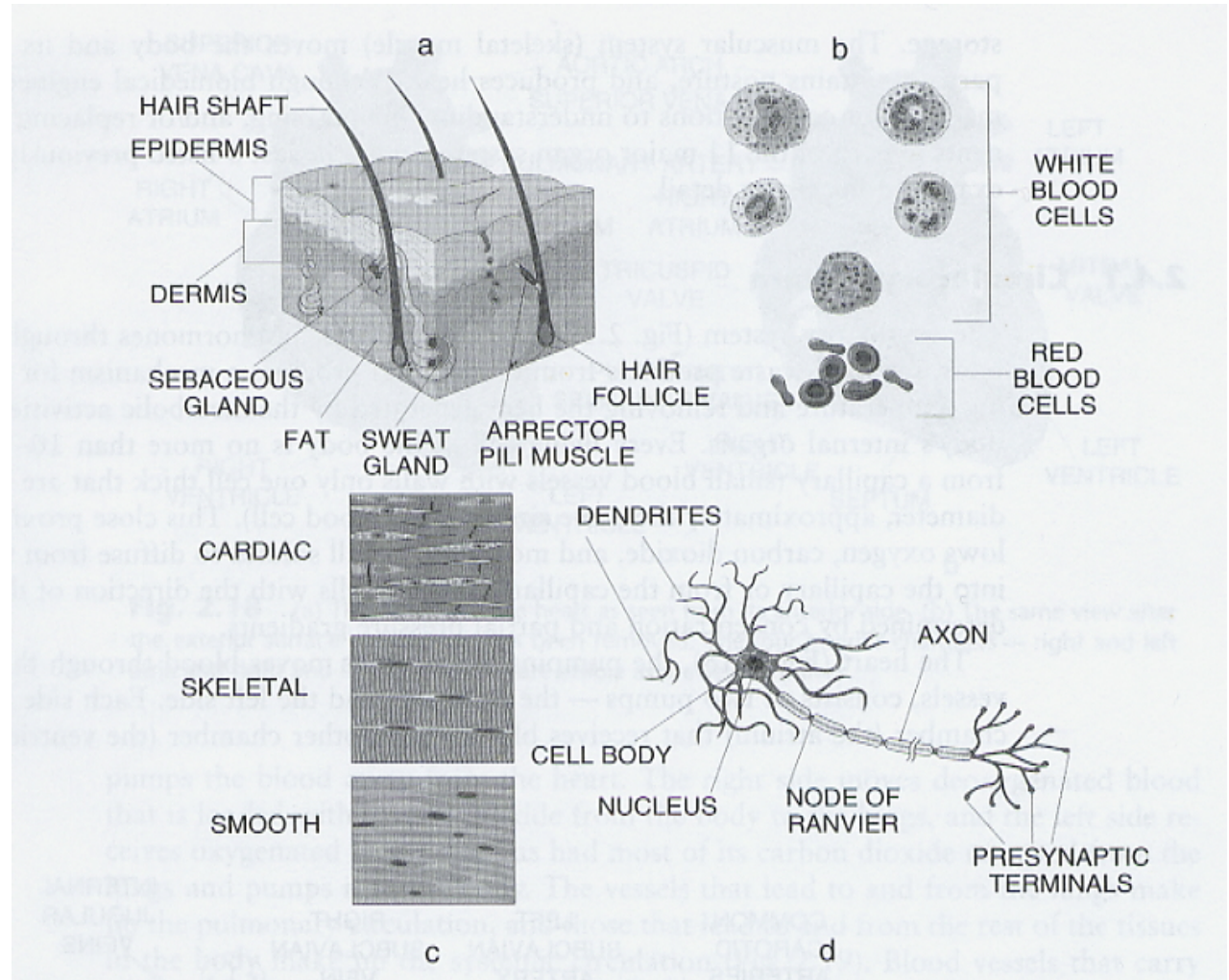
- primary types of tissues :

- Epithelial: For absorption(Small intestine lining), secretion(glands), transport(kidney tubules), excretion(sweat glands), and protection(skin)
- connective: bone, cartilage, and 'adipose tissue
- muscle: skeletal, smooth (intestines and blood vessel walls), cardiac
- nervous: neurons and glial cells (to protect,support and nourish neurons)



FIG 2.16. Four tissue types

- (a) Skin is a type of **epithelial tissue** that helps protect the body.
- (b) Blood is a specialized **connective tissue**.
- (c) There are three types of **muscle tissue** : cardiac, skeletal, and smooth.
- (d) Motor neurons is a type of **nervous tissue** that conduct electrical impulses from the central nervous system to effector or organs such as muscles.



■ 2.4. MAJOR ORGAN SYSTEMS

▶ The human body has 11 major organ systems

- integumentary(외피) system: skin, hair, nails, and various glands for protection.
- endocrine system: secretes hormones that regulate many chemical actions thru ductless glands such as the thyroid and adrenals
- lymphatic system: returns excess fluid and protein to the blood and helps defend the body against infection and tissue damage.(glands, lymph nodes, lymph, and lymphatic vessels)
- digestive system: ingests food and water, and removes solid wastes.
- urinary system:
- reproductive system
- circulatory system
- respiratory system
- nervous system
- skeletal system: bones and cartilage: production of blood cells and calcium and phosphorus storage
- muscular system



■ 2.4.1. Circulatory system



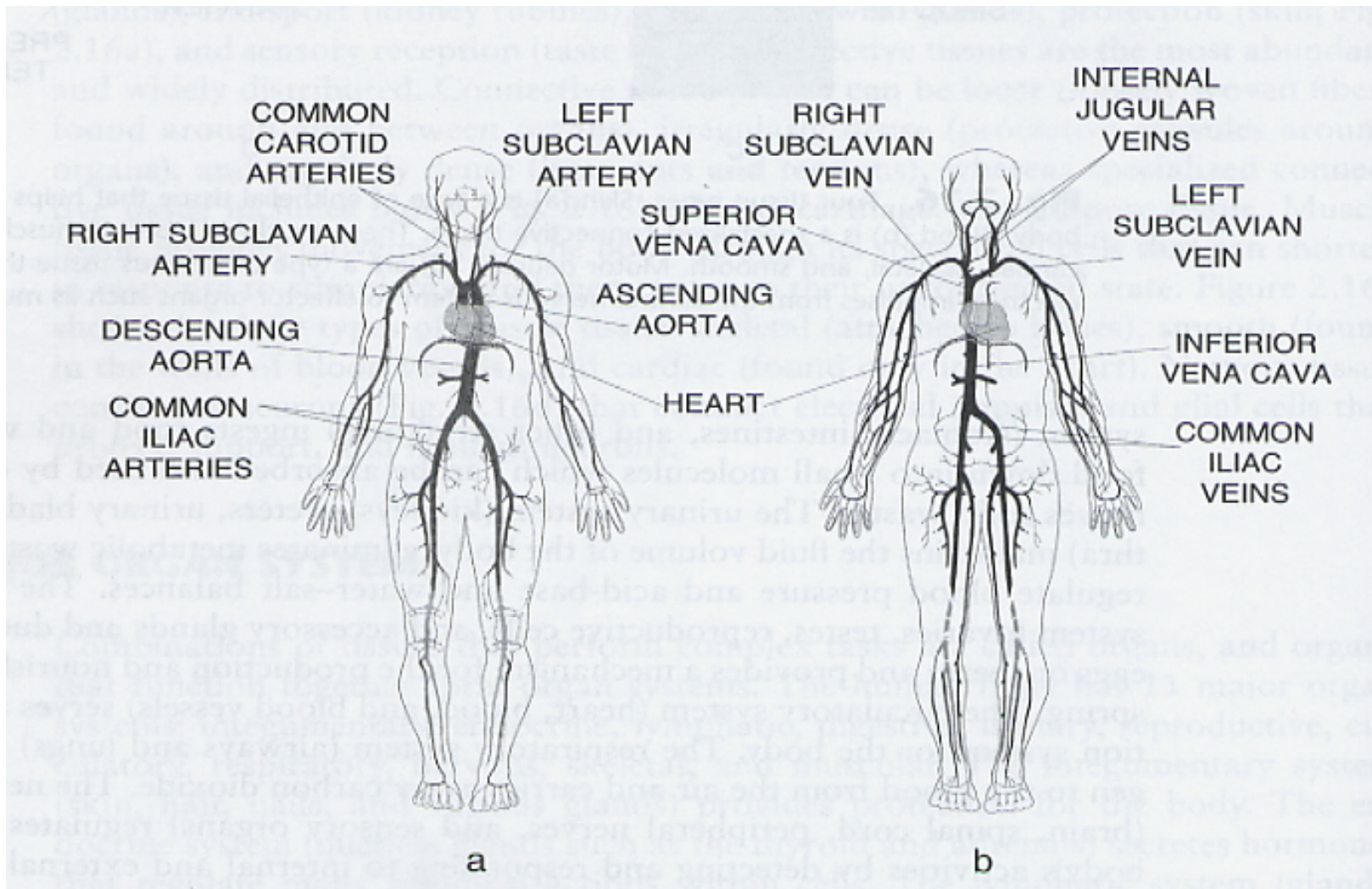


FIG 2.17. (a) The distribution of the main arteries in the body which carry blood away from the heart.

(b) The distribution of the main veins in the body which return the blood to the heart



A'orta:대동맥

Superior (Inferior) vena 'cava: 대정맥

'Pulmonary artery:폐동맥

Portal Vein: 문정맥

'Ca'rotid artery: 경동맥

Sub'clavian: 쇄골하

'Iliac:장골

'Jugular:경정맥



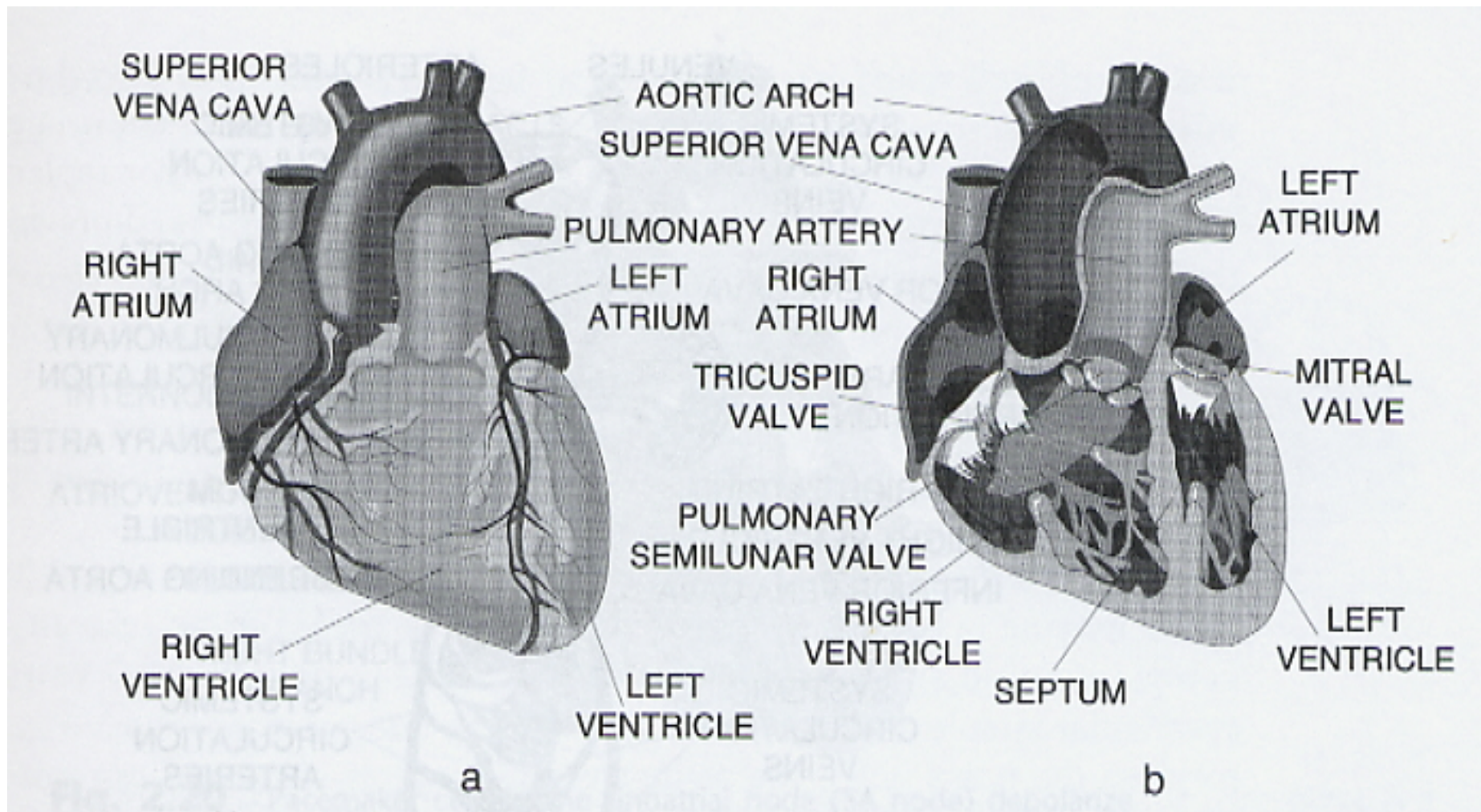


FIG 2.18. (a) The outside of the heart as seen from its anterior side.
 (b) The same view after the exterior surface of the heart has been removed. The four interior chambers – right and left atria and right and left ventricles – are visible as are several valves.



► **Heart** : the pumping station that moves blood through the blood vessels, consists of two pumps – the right side and the left side.

- **the right side** : to move deoxygenated blood that is loaded with carbon dioxide from the body to the lungs
- **the left side** : to receive oxygenated blood that has had most of its carbon dioxide removed from the lungs and pumps it to the body

Vena cana-> r.a. and r.v->pulmonary artery
->lung >pulmonary vein-> l.a and l.v->aorta->body



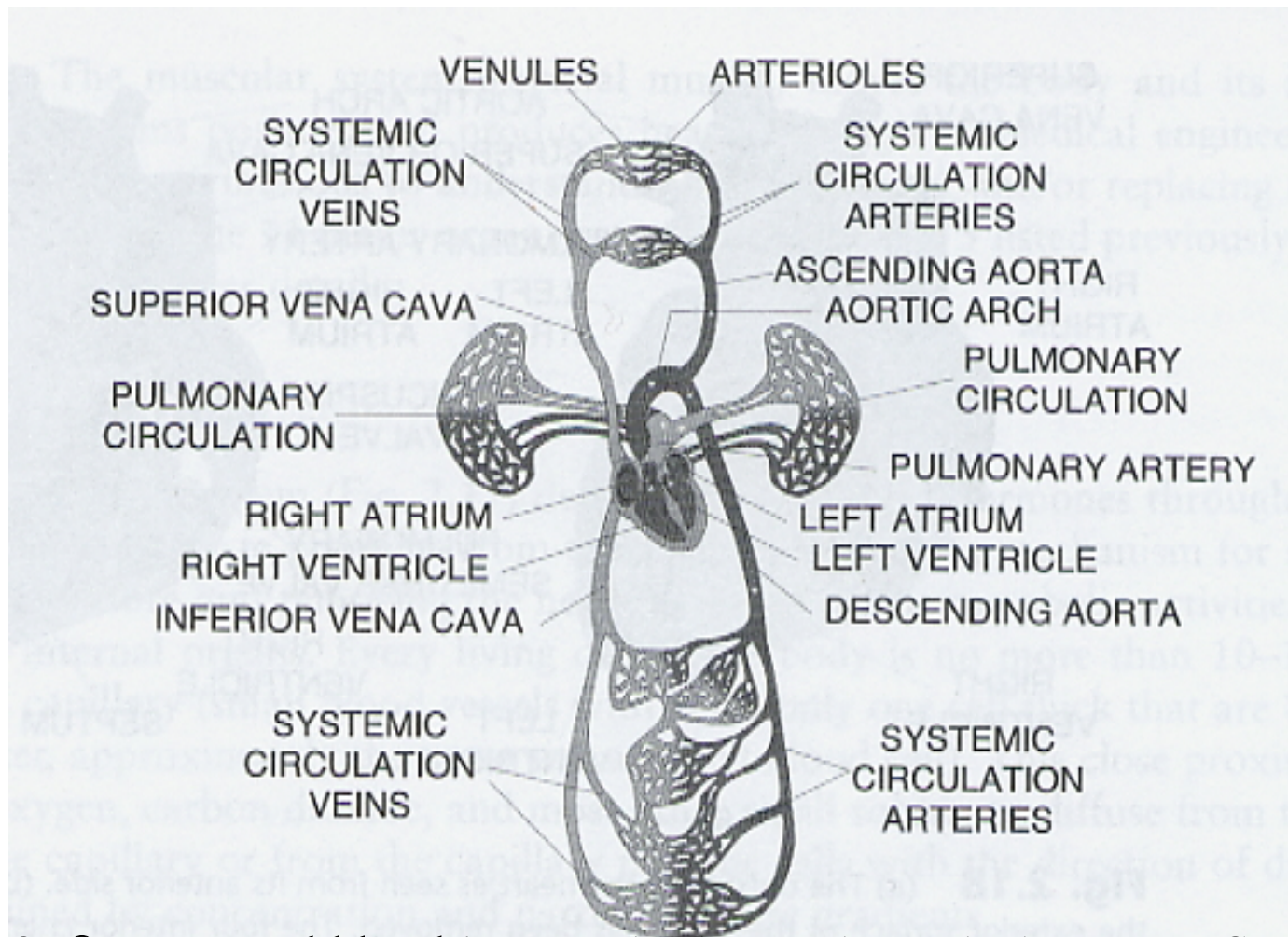


FIG 2.19. Oxygenated blood leaves the heart through the aorta. Some of the blood is sent to the head and upper extremities and torso, whereas the remainder goes to the lower torso and extremities.

The blood leaves the aorta and moves into other arteries, then into smaller arterioles, and finally into capillary beds where nutrients, hormones, gases, and waste products are exchanged between the nearby cells and the blood.



The blood moves from the capillary beds into venules and then into veins. Blood from the upper part of the body returns to the right atrium of the heart through the **superior vena cava**, whereas blood from the lower part of the body returns through the **inferior vena cava**.

The blood then moves from the right atrium to the right ventricle and into the pulmonary system through the **pulmonary artery**.

After passing through capillaries in the lungs, the oxygenated blood returns to the left atrium of the heart through the **pulmonary vein**. It moves from the left atrium to the left ventricle and then out to the systemic circulation through the **aorta** to begin the same trip over again



- at any one time, the average adult has about 5 liter of blood : 75% of the blood is in the systemic circulation in the veins, 20% is in the arteries, and 5% is in the capillaries.
- Each time the heart beats, about 80ml of blood leave the heart. The average red blood cell makes one complete cycle of the body during 60 beats.



► cardiac cycle

- the repeating pattern of contraction (systole) and relaxation (diastole) of the chambers of the heart
- SA(Sinoatrial)node: pacemaker cells self generate electrical pulses. depolarizes(from about -90mV to 20 mV) every 0.83 sec .
- Heart rate (72 beats / min) \Rightarrow $5/8$ (used to diastole) , $3/8$ (used to systole)



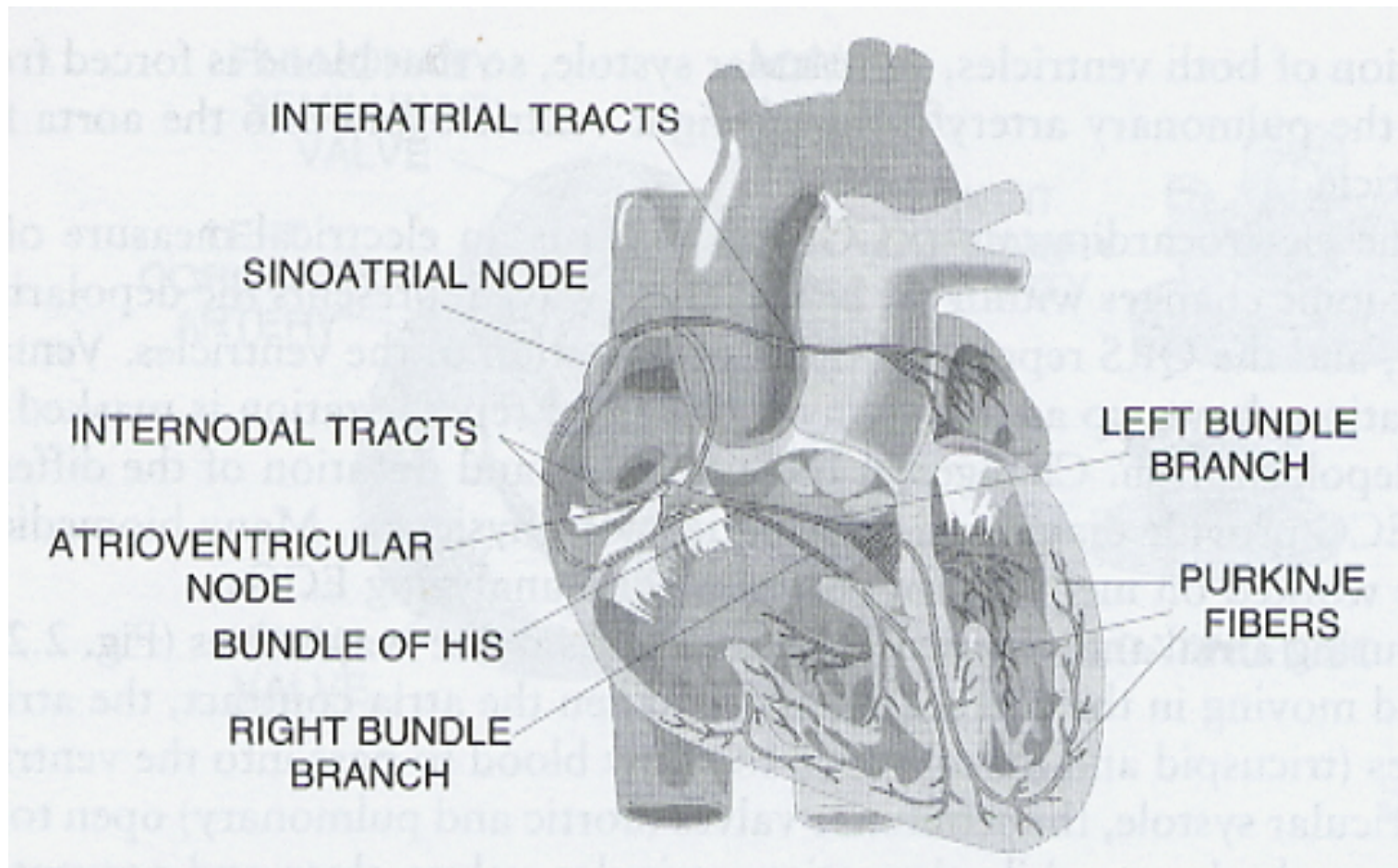


FIG 2.20. Pacemaker cells in the sinoatrial node (SA node) depolarize first and send an activation wavefront through the atria.

The propagating action potential slows down as it passes through the atrioventricular node (AV node) and then moves through the Bundle of His and Purkinje system very rapidly until it reaches the cells of the ventricles.



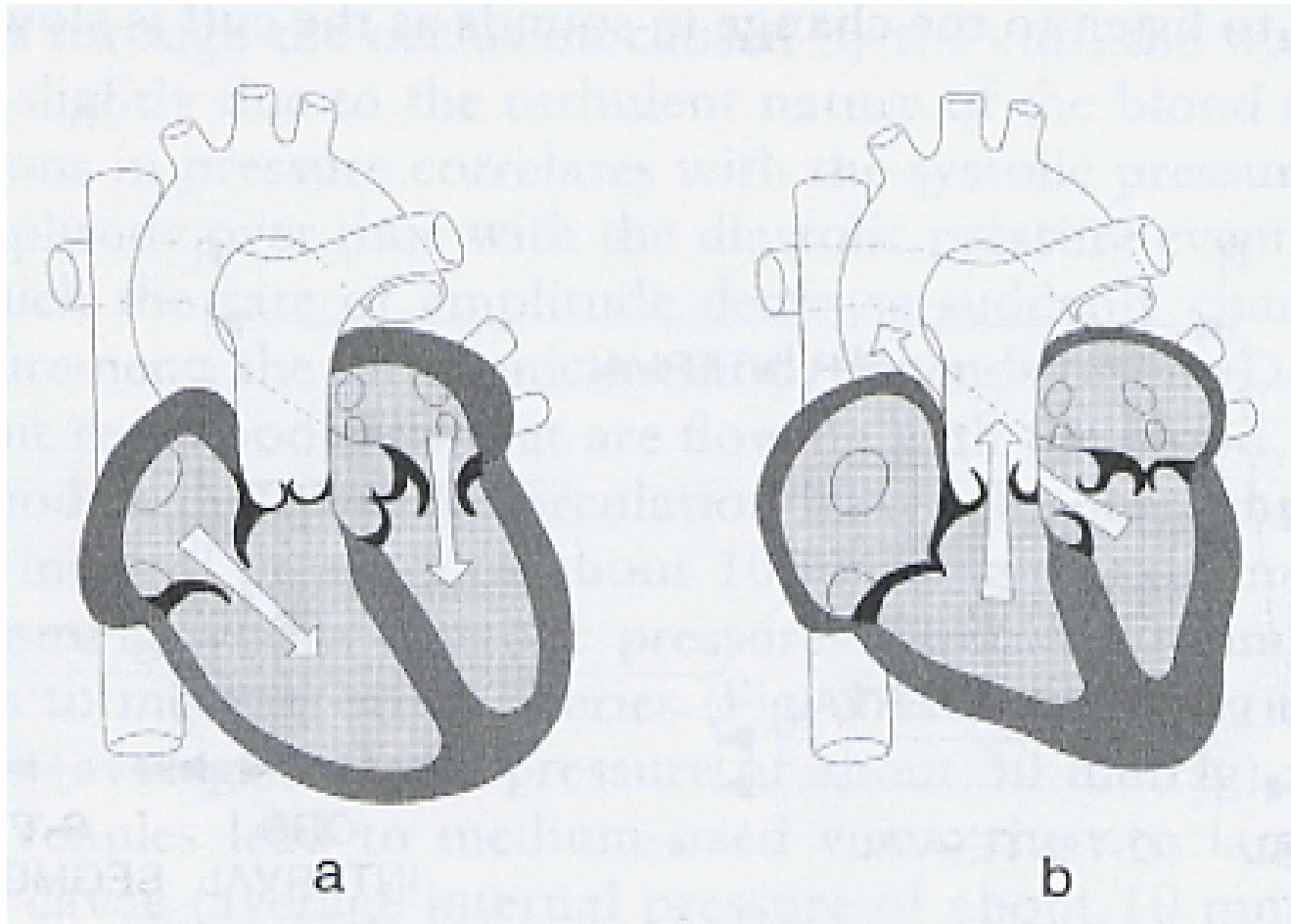


FIG 2.21. (a) During the first part of the cardiac cycle, the atria contract(atrial systole) and move blood into the ventricles.
(b) During the second part of the cardiac cycle, the atria relax(diastole), and the ventricles contract(ventricular systole) and move blood to the lungs (pulmonary circulation) and to the rest of the body (systemic-circulation).



- ▶ **ECG** : an electrical measure of the sum of these ionic changes within the heart

- P wave : the depolarization of the atria
- QRS : the depolarization of the ventricles
- T wave : the repolarization of the ventricular
- Atrial repolarization : masked by ventricular depolarization



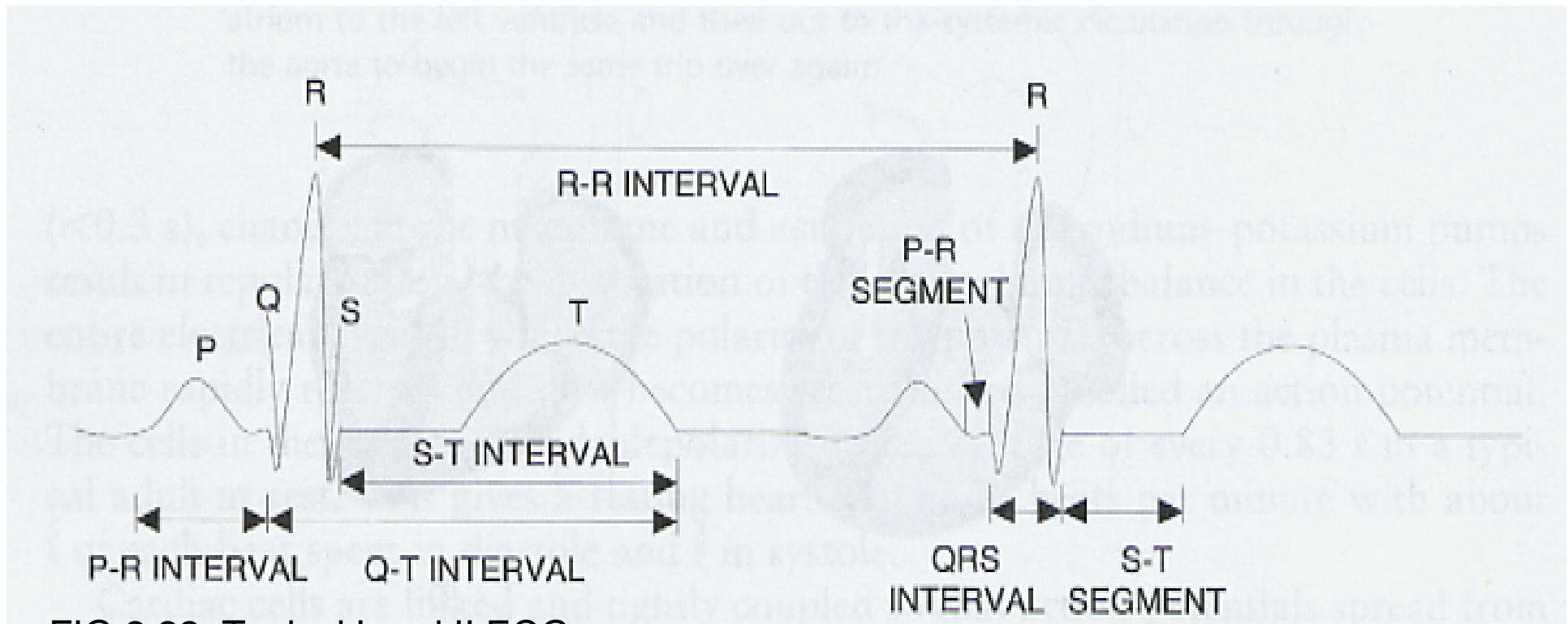


FIG 2.22. Typical Lead II ECG.

This electrocardiogram is typical of one that would be recorded from the body's surface by having a positive electrode on the left leg and a negative electrode on the right arm.

The vertical direction represents voltage and the horizontal direction represents time. The P, R, and T waves are easily identified and are the result of the movement of ions in cells in different parts of the heart.

Different intervals and segments have been identified which provide information about the health of the heart and its conduction system. The R-R interval can be used to determine heart rate.



► **blood pressure** in the systemic circulation

- aorta : 100 mmHg (120 mmHg ~ 80mmHg)
- capillary : 30 mmHg
- vena cava(right atrium) : 10 mmHg
- blood flow :
 - highest in the large arteries and veins (0.3~0.4 m/s in the aorta, 0.05 m/s in the vena cavae)
 - lowest in the capillary bed (1mm/s)
- Due to the decreased pumping power of the smaller right ventricle(compared to left), pressures in the pulmonary circulation are lower (25/10 mmHg) than in the systemic circulation.



▶ 2.4.3.nervous system

- ■ the central nervous system
 - the peripheral nervous system
- ■ somatic nervous system
 - autonomic nervous system



- ▶ somatic and autonomic systems consist of components from both the central and peripheral nervous system
- **somatic peripheral nervous system** : sensory neuron, motor neuron
- **autonomic nervous system** : the involuntary regulation of smooth muscle, cardiac muscle, glands
 - sympathetic division : prepare the body for “fight or flight”
 - parasympathetic division : return the body to normal operating condition



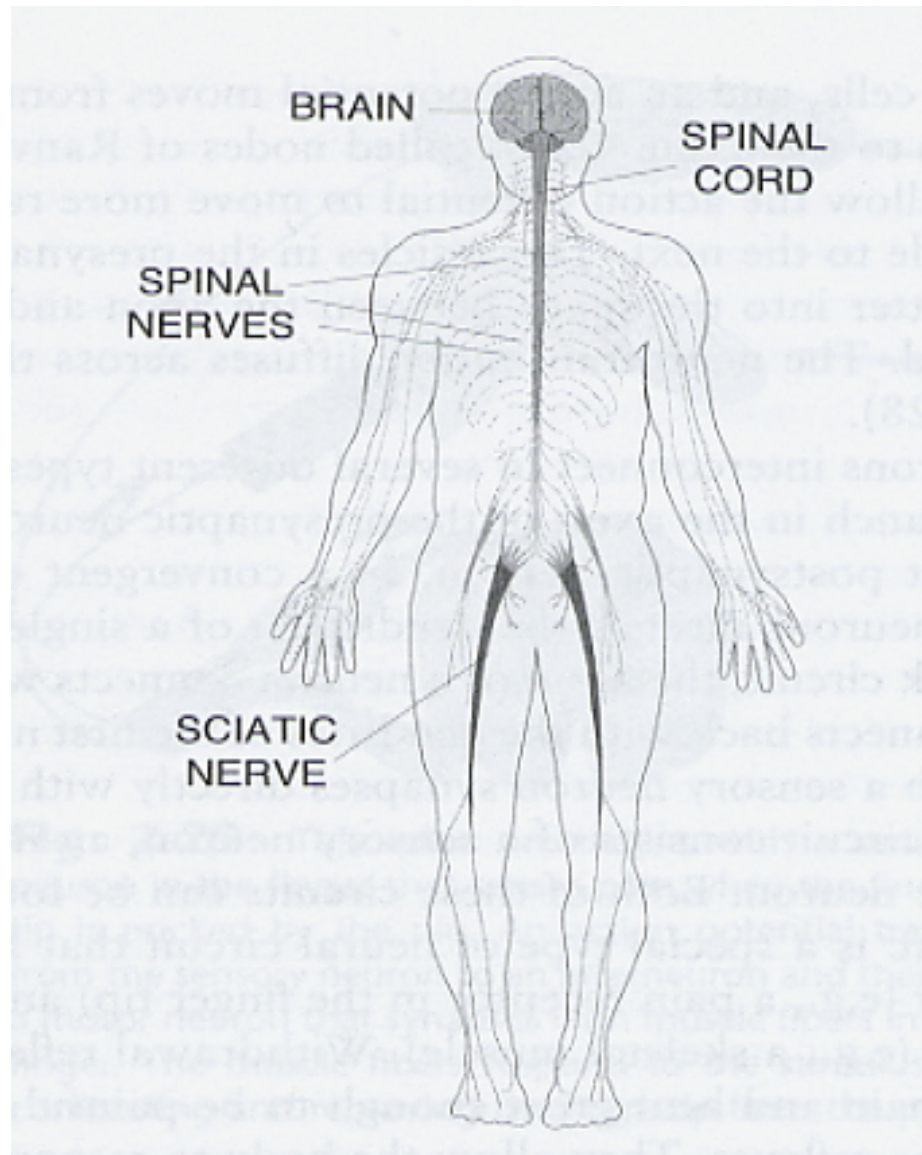
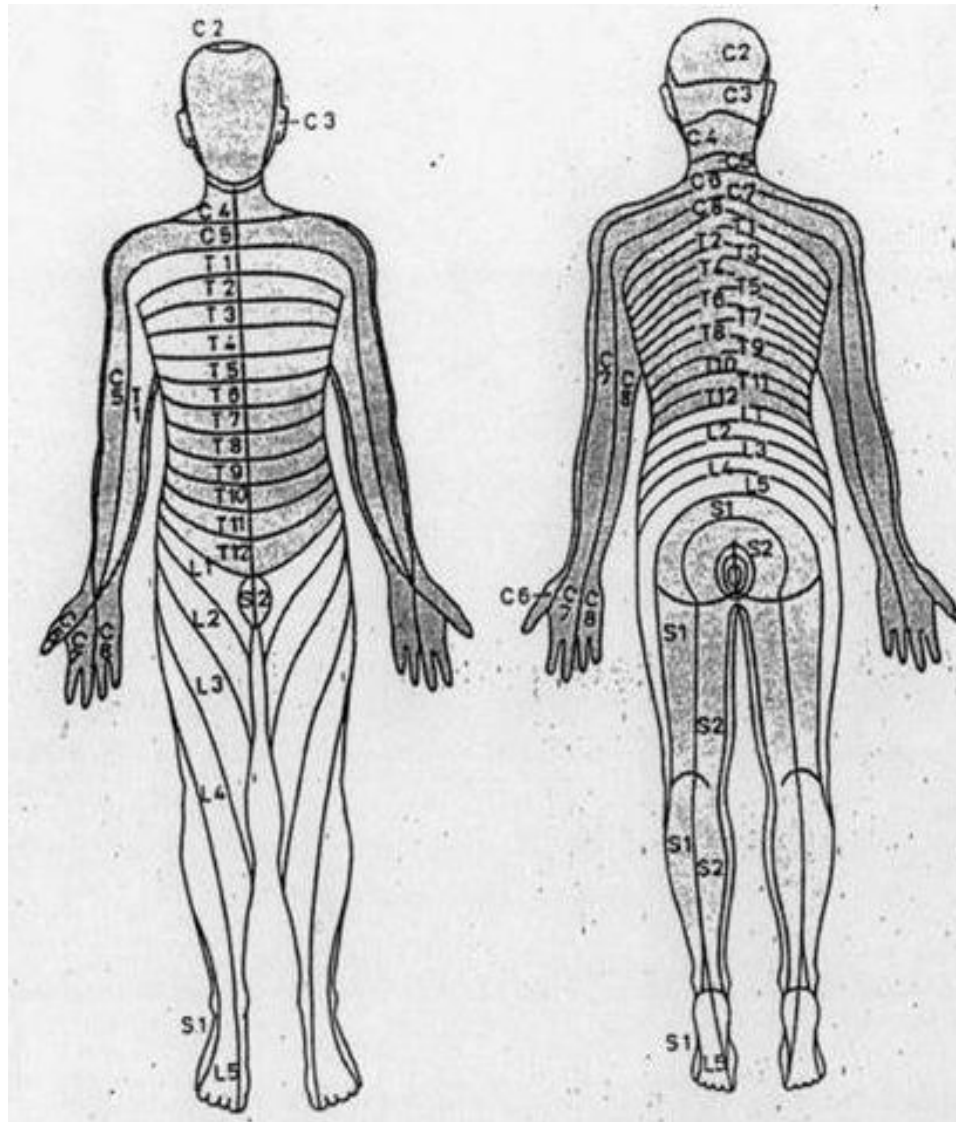


FIG 2.27. The central nervous system(CNS) consists of all nervous tissue that is enclosed by bone, i.e., the brain and spinal cord, whereas the peripheral nervous system(PNS) consists of the nervous tissue that is not encased by bone





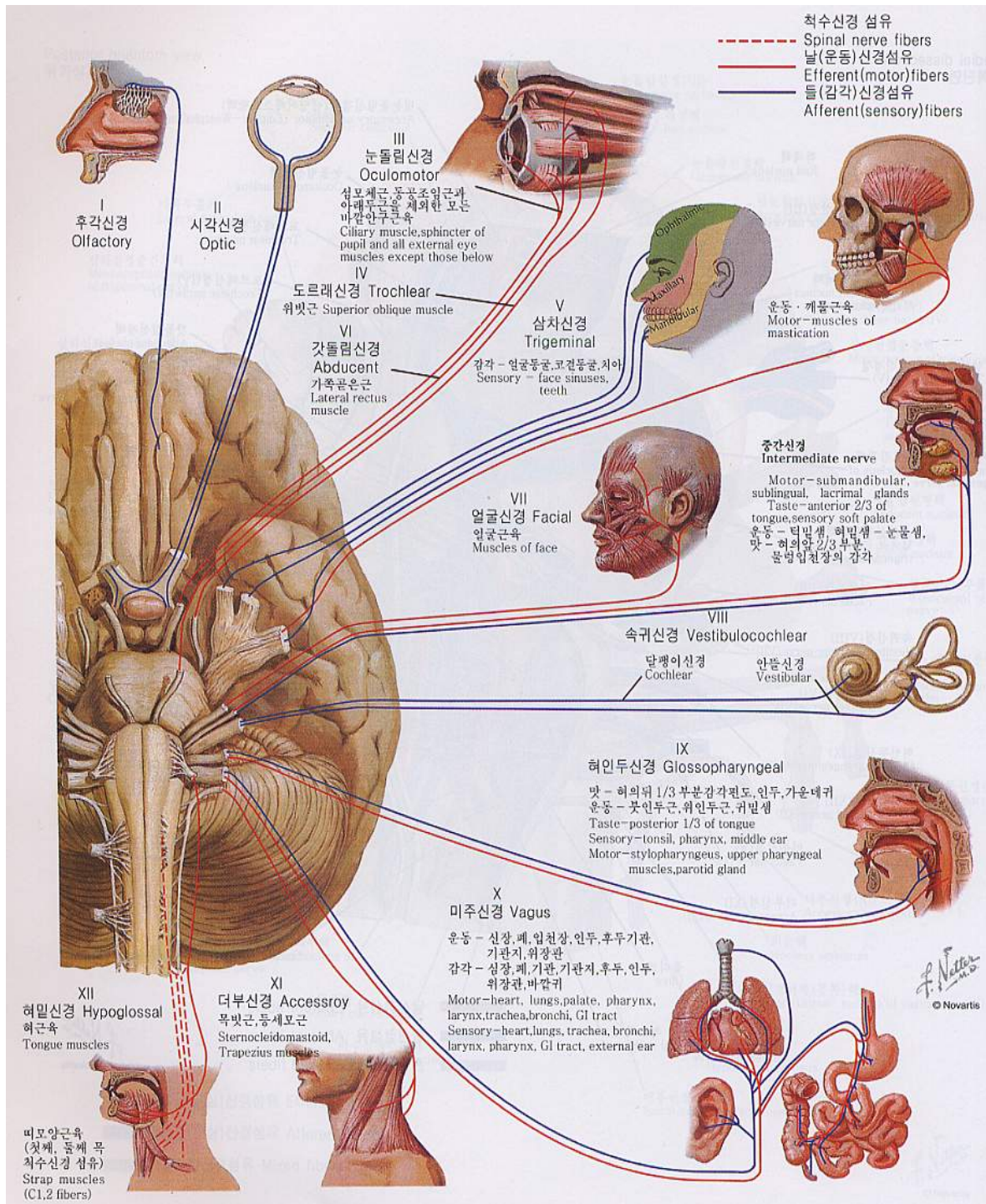
Cranial nerves 12pairs

Olfactory	(후)
Optic	(시)
Oculomotor	(동안)
Trochlear	(활차)
Trigeminal	(삼차)
Abducent	(외전)
Facial	(안면)
Vestibulo-cochlear	(내이)
Glossopharyngeal	(설인)
Vagus	(미주 : 迷走)
Accessory	(부)
Hypoglossal	(설하)

Spinal nerves 31pairs

Cervical	(경)
Thoracic	(흉)
Lumbar	(요)
Sacral	(천골)
Coccygeal	(미골)





Cranial Nerves (Motor and Sensory Distribution): Schema

Atlas of Human Anatomy,

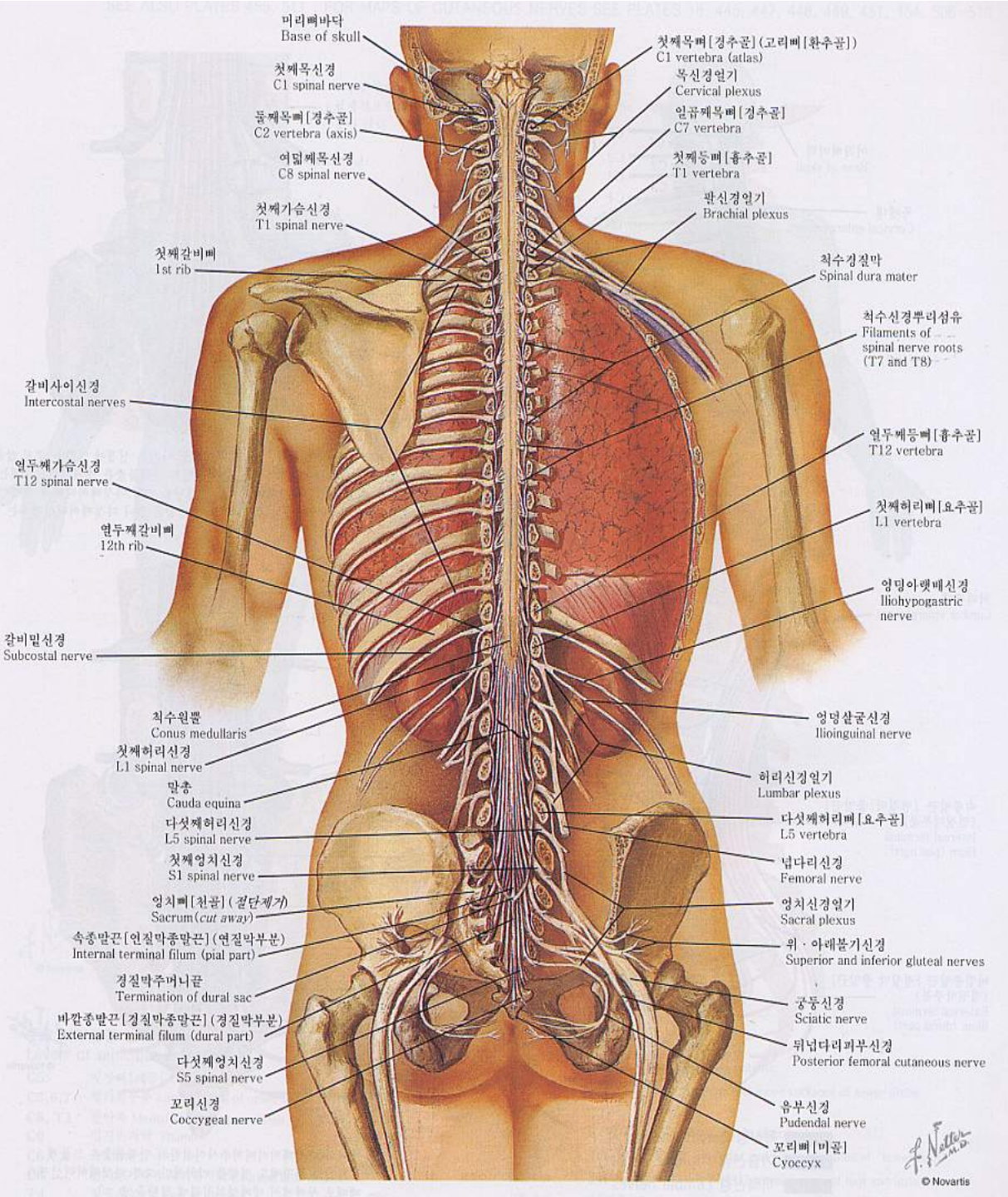
Frank Netter, 2nd ed.

Novartis, East Hanover, NJ, USA.

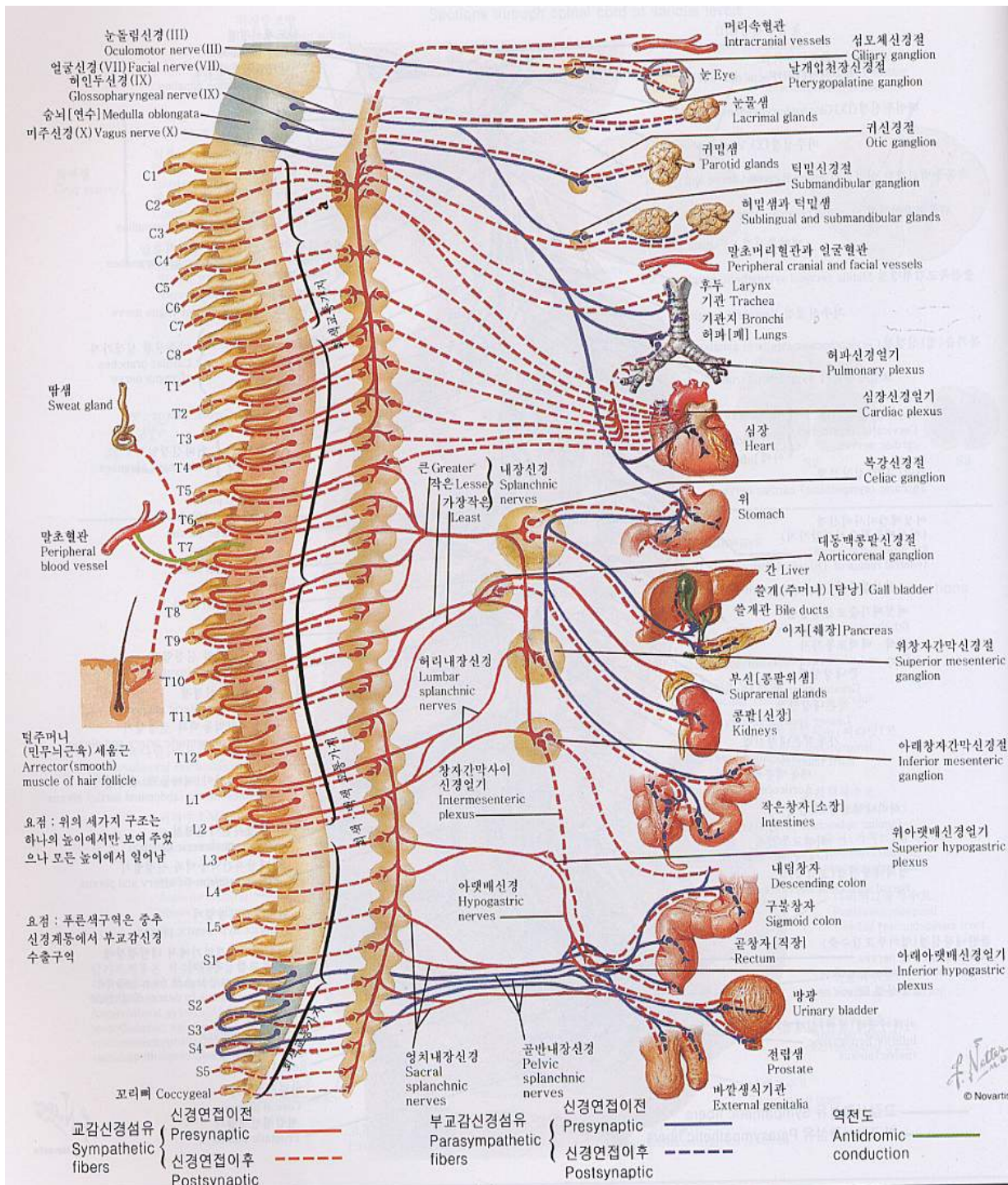


Intro. To BME

Spinal Cord In Situ



Autonomic Nervous System: Schema



Intro. To BME

cells

- Neurons to conduct electrical impulses
- **Glial cells to protect, support, and nourish neurons**
- **cell body of the neuron**
- **dendrites** : the main receptor portion of the neuron
- **axon** : carry nerve signals to other nerve cell
 - Presynaptic terminals: knoblike protrusion containing synaptic vesicles holding neurotransmitter



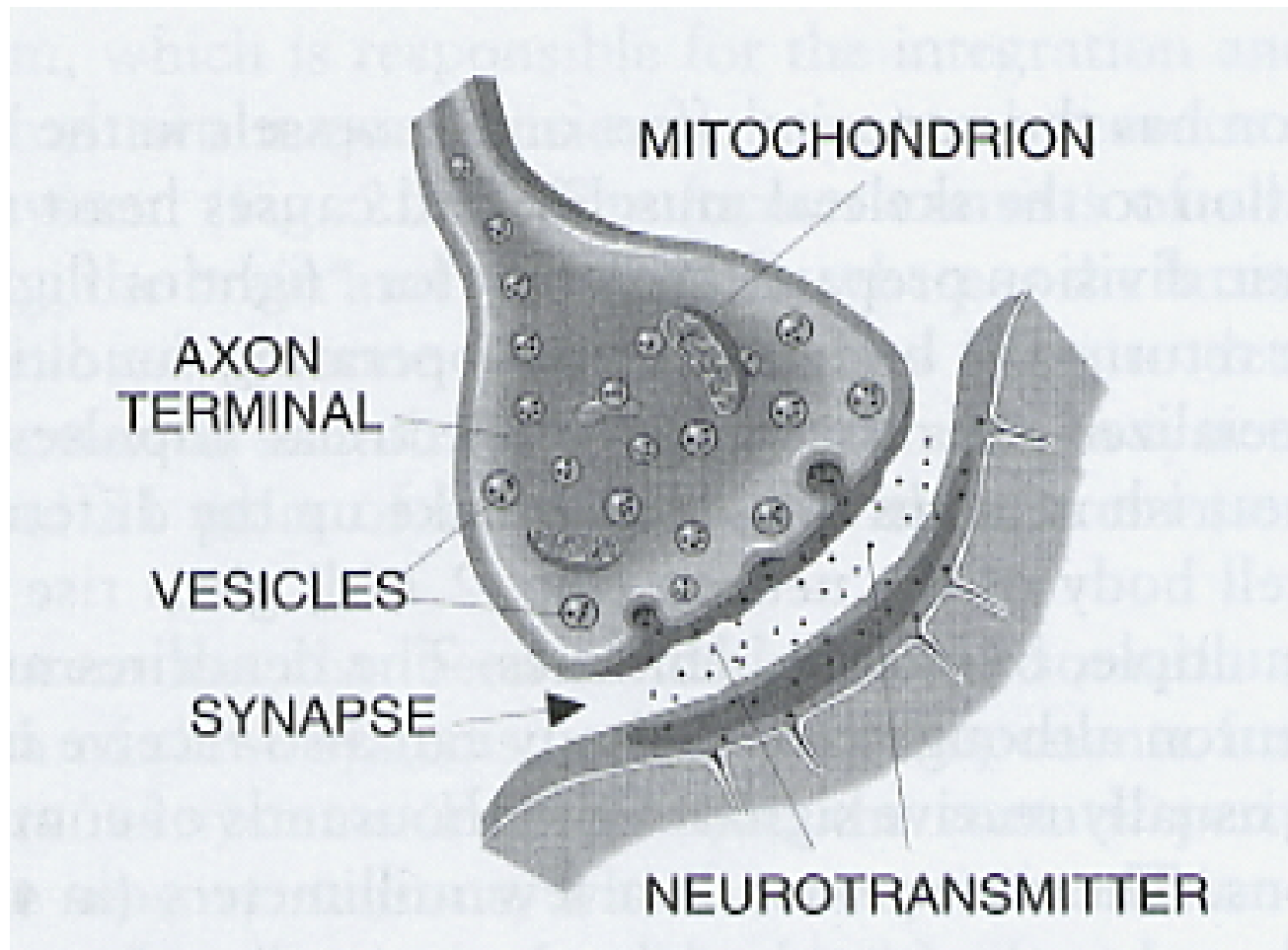
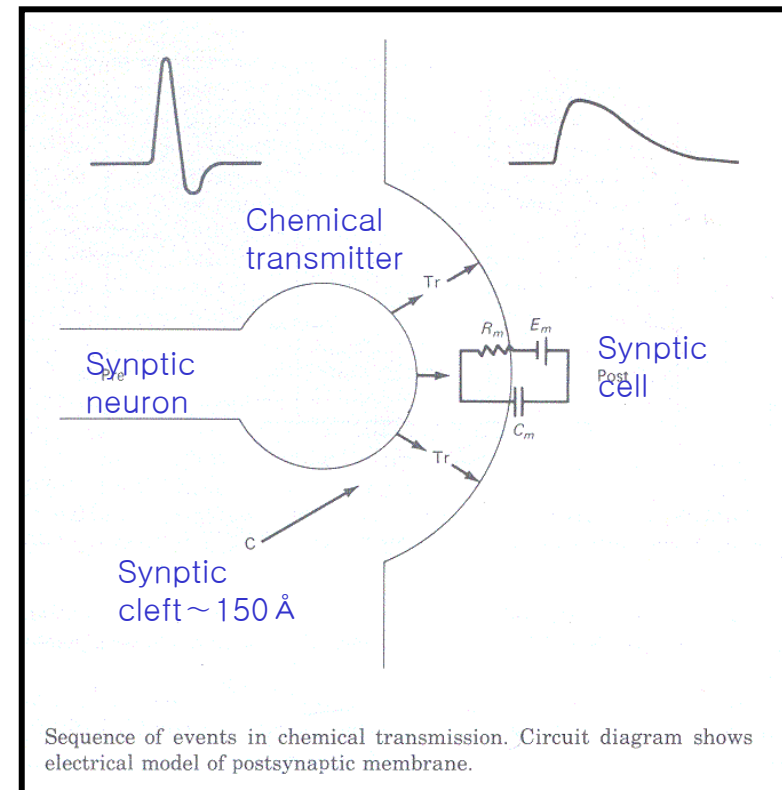


FIG 2.28. Following stimulation, vesicles in the axon terminal move to the synapse by means of **exocytosis and release neurotransmitters** into the space between the axon and the next cell which could be the dendrite of another neuron, a muscle fiber, or a gland. The neuro-transmitters diffuse across the synapse and elicit a response from the adjacent cell.



Synaptic potentials

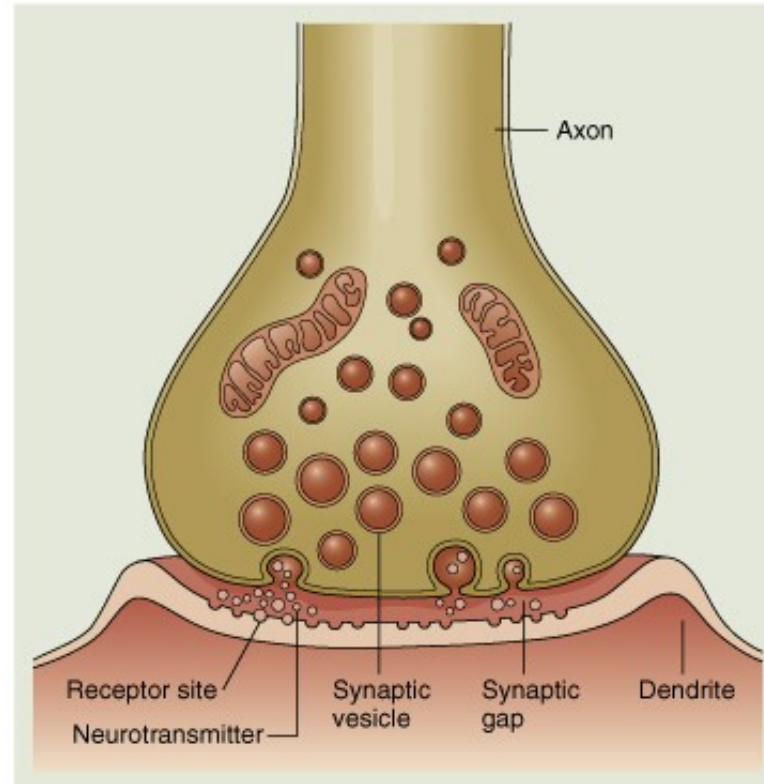
- Chemical transmitter
 - Acetylcholine
 - Nor adrenaline ≡
- Synapse : junction across one nerve cell excites another.
 1. Chemically coupled ~ 0.5 msec delay
 2. Electrically coupled
- EPSP (Excitatory Post synaptic Potential) causes depolarization. Subthreshold EPSP can add to raise potential above V_{th} .
- IPSP (Inhibiting \sim) causes hyperpolarization.



- 시냅스 (synapse) :

활동전위가 신경말단에 도달하면
 신경말단에 접하고 있는 표적세포에
 전해져야 하며 이는 신경전달물질
 (neurotransmitter)이라고 알려진 화학
 물질에 의해 전기신호로부터 변환되어
 이루어진다.

신경전달물질	작용
Acetylcholine	흥분성
Glutamic acid	흥분성
GABA	억제성
Glycine	억제성



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► major part of brain

- Ce'rebrum
- Dien'cephalons
- brain stem and cere'bellum

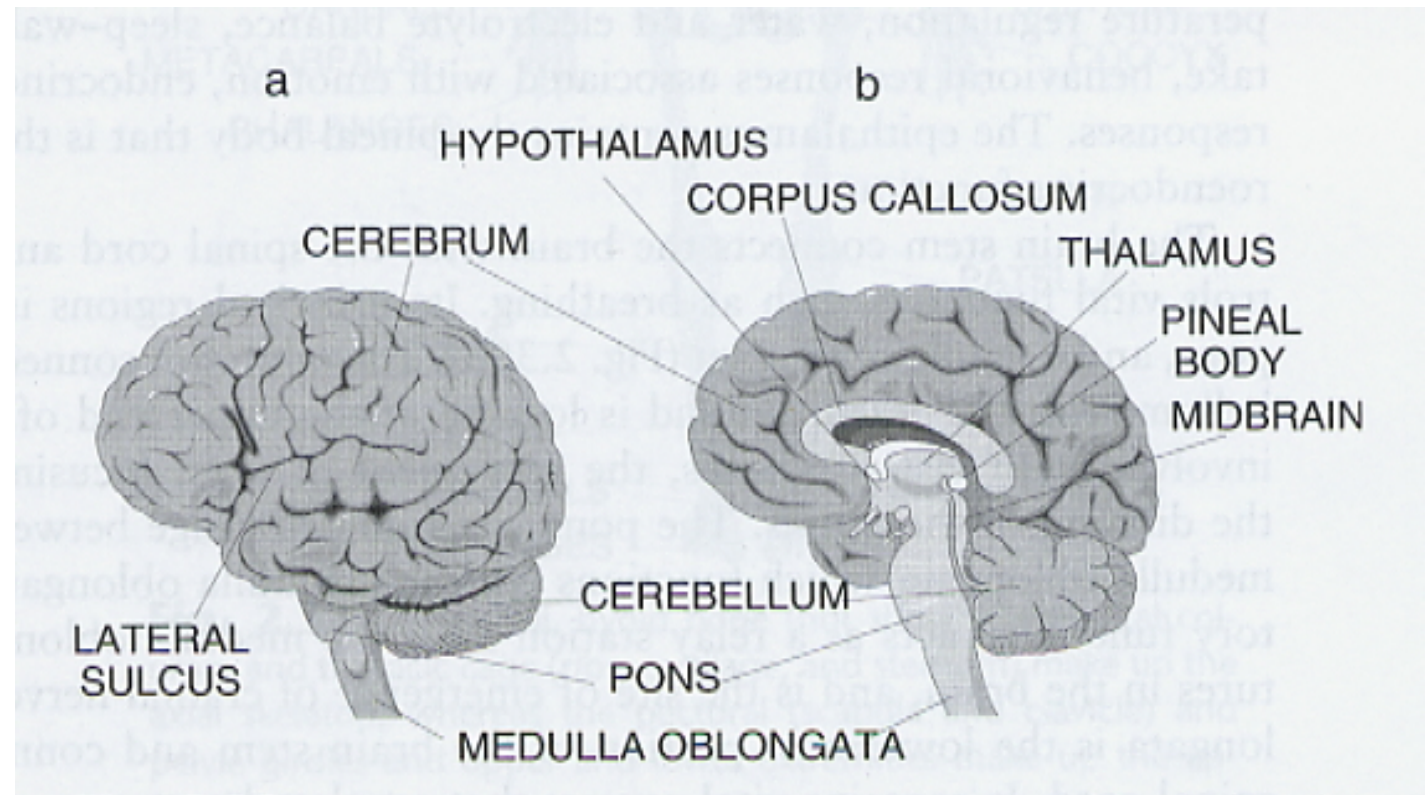
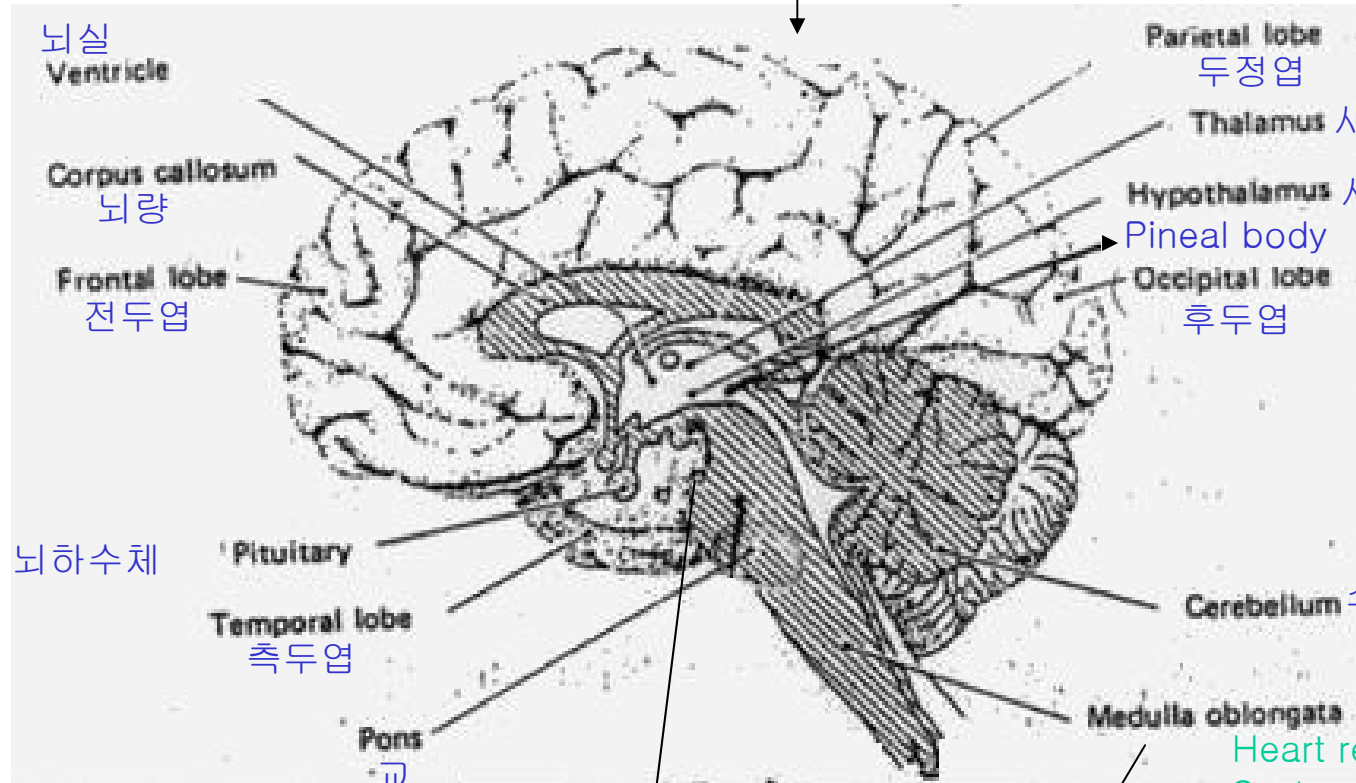


FIG 2.30. (a) The exterior surface of the brain (b) A mid'sagittal section through the brain.



Gyrus(회)
-elevation Cerebral sulcus
-grooves

후각을 제외한
모든 감각을 뇌피질로 전달



Diencephalon
간뇌

body temp. ,sleep ,
appetite ,emotion ,
전해질 조절

소뇌 : 평행유지 , 근육
상태조절,수의근 운동

Heart regulation , respiratory
System 등. (심박동, 혈압 ,호흡
, 타액분비 ,기침 , 구토 등)

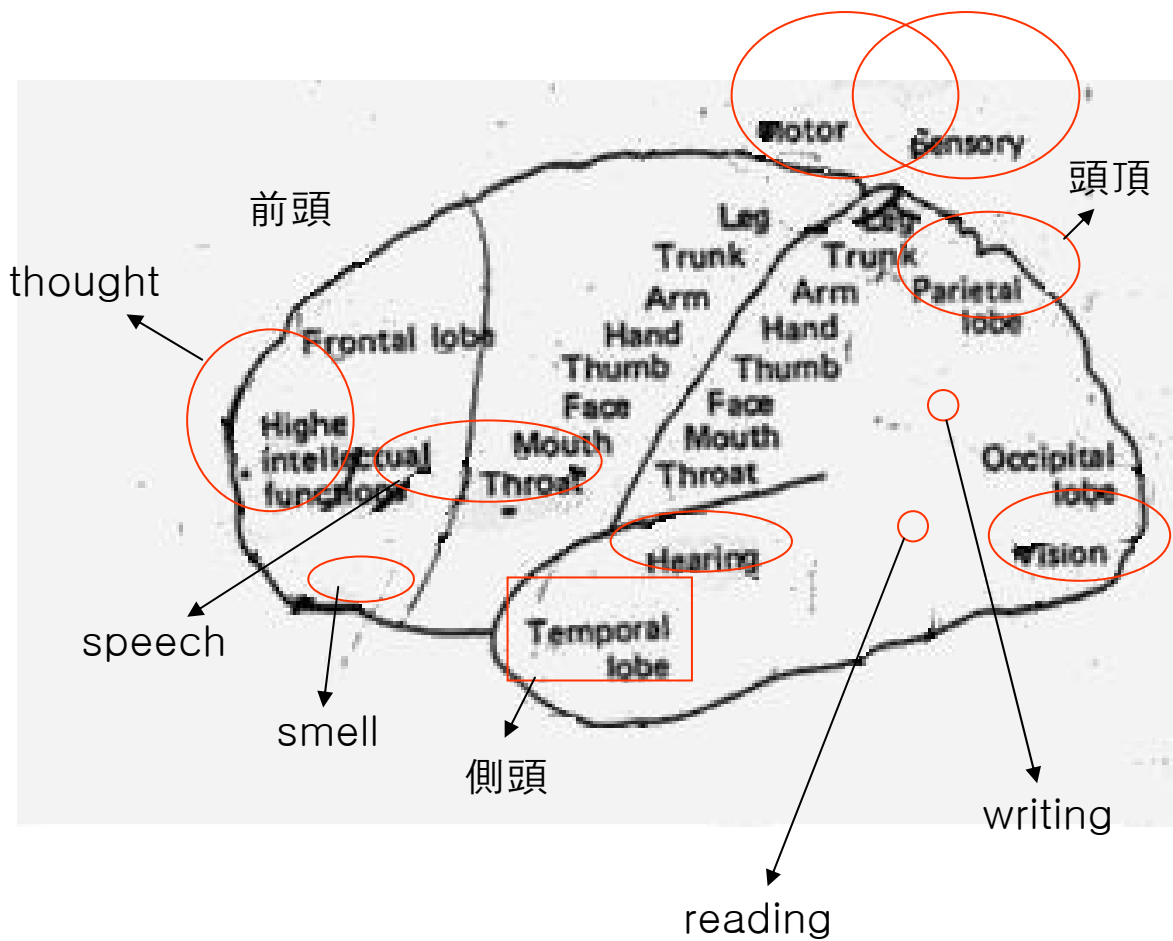
소뇌와 연결,운동에 관여

midbrain
시각,청각,신도

연수
pons
midbrain } Brain stem
뇌간 ~ 뇌의 축



Intro. To BME



Cerebral cortex
: 知, 情, 意의 중추



▶ cerebrum

- divided into two hemispheres
- consist of gyri(회), sulci(구), and deep fissures(열).
- Outer layer : gray matter(neurons with unmyelinated axons) Cerebral cortex :2-4mm thick, 50 billion cells and 250 billion glial cells (neuroglia)
- Inner layer : white matter(interconnecting group of myelinated axons)
- Corpus callosum(뇌량) : connection between the two cerebral hemispheres
- left side controls the right side of the body
- right side controls the left side of the body



► Lobes divided by **fissures**

- **frontal lobes** : voluntary movements, analysis of sensory inputs, personality, mediating responses related to memory, emotions, reasoning, judgment, planning, and speaking
- **the parietal lobes** : responding to stimulation from skin and muscle receptors
- **the temporal lobes** : interpret and store some sensory experiences, store memories of auditory and visual experiences, contain auditory centers that receive sensory neurons from the cochlea fo the ear
- **the occipital lobes** : integrate eye movement by directing and focusing the eye and are responsible for correlating visual images with previous visual experiences and other sensory stimuli
- **the insula** : deep portion of the cerebrum under parietal, frontal, and temporal lobes, little known.



► diencephalons

- connect the midbrain of the brain stem with the cerebral hemispheres.
- main parts:
 - ▪ thalamus : involved with sensory and motor systems, general neural background activity, expression of emotion and uniquely human behaviors. Due to its two-way communication with areas of the cortex, it is linked with thought, creativity, interpretation and understanding of spoken and written words, and identification of objects sensed by touch.
 - ▪ hypothalamus: involved with integration within the autonomic nervous system, temperature regulation, water and electrolyte balance, sleep-wake patterns, food intake, behavioral responses associated with emotion, endocrine control, and sexual responses
 - ▪ epithalamus: contains pineal body thought to have a neuroendocrine function.



- ▶ brain stem connects the brain with the spinal cord and automatically controls vital functions such as breathing.
- midbrain : visual reflexes, the movement of eyes, focusing of the lenses, and the dilation of the pupils
- pons : control respiratory function
- medulla oblongata : vital center that regulates heart rate, respiratory rate, constriction and dilation of blood vessels, blood pressure, swallowing, vomiting, sneezing, and coughing



- ▶ **cerebellum** processes sensory information used by the motor systems and is involved with coordination of skeletal muscle contractions and impulses for voluntary muscular movement that originate in the cerebral cortex. Processing center that is involved with coordination of balance, body positions, and the precision and timing of movements

