

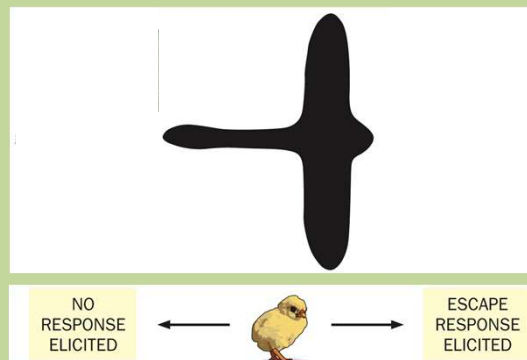
2021 Fall "Physiology"

Introduction of Neuroscience

Dong-Gen LUO

College of Life Sciences
Peking University

Escaping Behaviours



Hunting by Ear



Figure 1-5 Principles of Neurobiology (© Garland Science 2016)

Memory

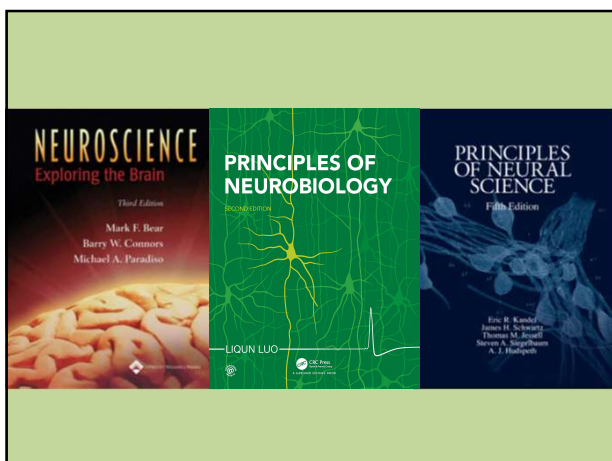
Sleep

How we see?
hear?
reason?
learn?
remember?
forget?
act?

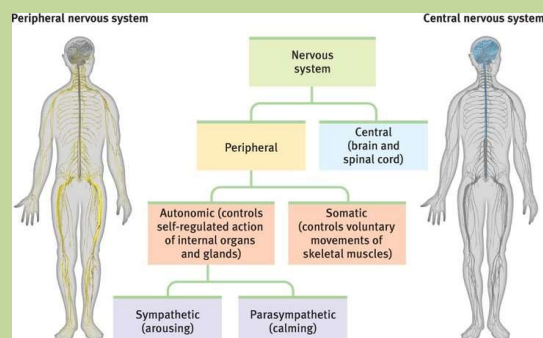
Why happy?
depressed?
sleep?
dream?

The power of Speech.

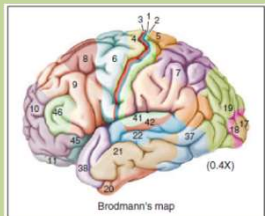
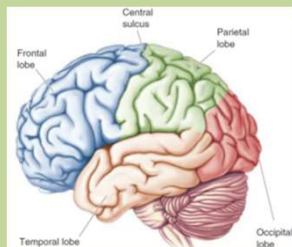
Emotions



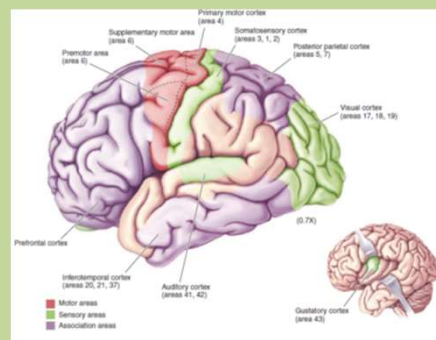
Nervous Systems



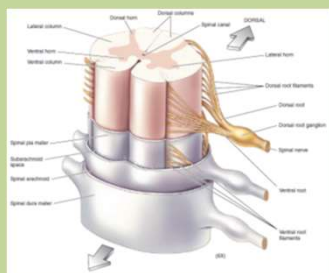
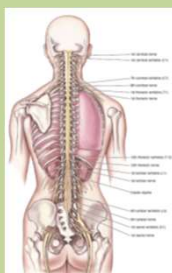
Cortex



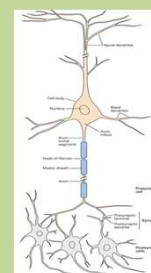
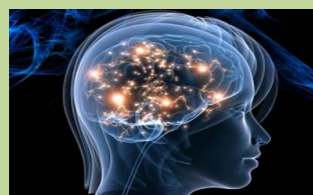
Cortex



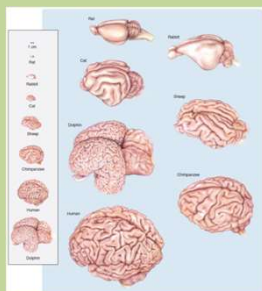
Spinal Cord



Neurons in the Brain

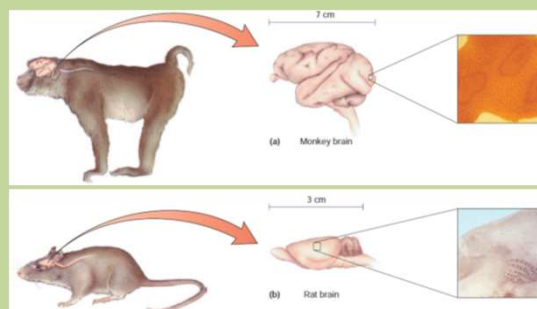


Brain Size and Neuron Numbers

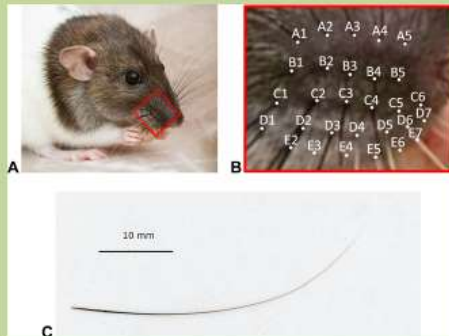


Species	Neurons	Synapses
Human	9×10^{10}	$10^{14} - 10^{15}$
Rat	2×10^8	10^{11}
Mouse	7×10^7	10^{11}
Frog	1×10^7	
Fruit Fly	1×10^5	10^7
C. elegans	302	7,500

Brain and Functions

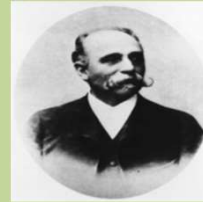


Rat Whiskers and Brain Map



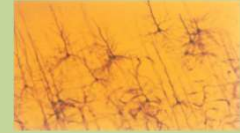
Foundation of Neuroscience

Camillo Golgi (1843-1926)
Italian physician/pathologist



Silver Staining

Method: Potassium dichromate
Silver nitrate

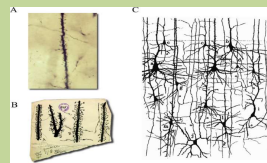


Results: Brown/Black cells
Yellow background

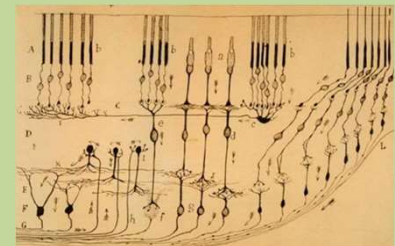
Ramon y Cajal (1852-1934)
Spanish pathologist/neuroscientist



"What an unexpected sight! Sparse, smooth and thin black filaments or thorny, thick, ... against a perfectly translucent yellow background!...this is the Golgi method."



Neuron Doctrine

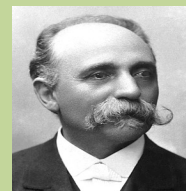


NEURAL DOCTRINE

RETICULAR THEORY



The Nobel Prize in Physiology or Medicine 1906



The Nobel Prize in Physiology or Medicine 1906 was awarded jointly to Camillo Golgi and Santiago Ramon y Cajal "in recognition of their work on the structure of the nervous system"

Microscopy resolution



Abbe's equation

$$\text{Limit of resolution} = \frac{0.61 \times \lambda}{NA}$$

Wavelength of an electron

$$\lambda = \frac{1.23 \text{ nm}}{\sqrt{V}}$$

Transmission electron microscope (10^5 V)

$$\text{Limit of resolution} = 0.24 \text{ nm}$$

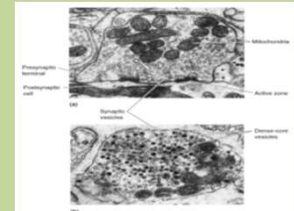
Synapse

Charles Sherrington (1857-1952)
English neurophysiologist

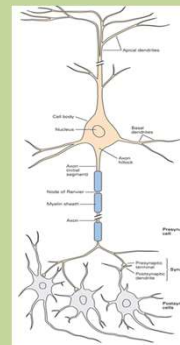
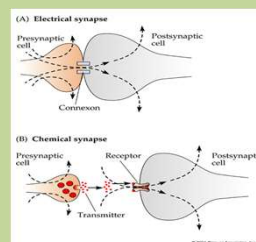
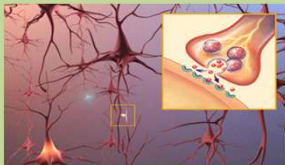


1932 Nobel Prize in Physiology or Medicine
"work on the structure of the nervous system"

1954 TEM work by
George Palade, Eduardo de Robertis and George Bennett,



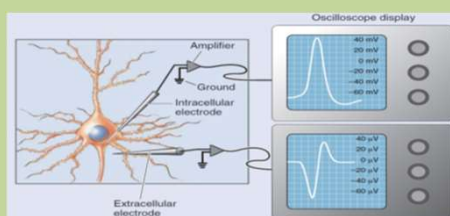
Synaptic Communication



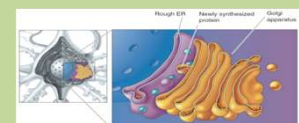
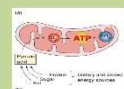
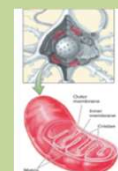
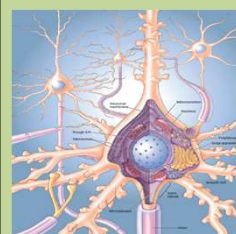
Features of Neurons

1. Polarized structures (dendrite/axon);
2. Electrically and chemically excitable;
3. Synaptic release machine.

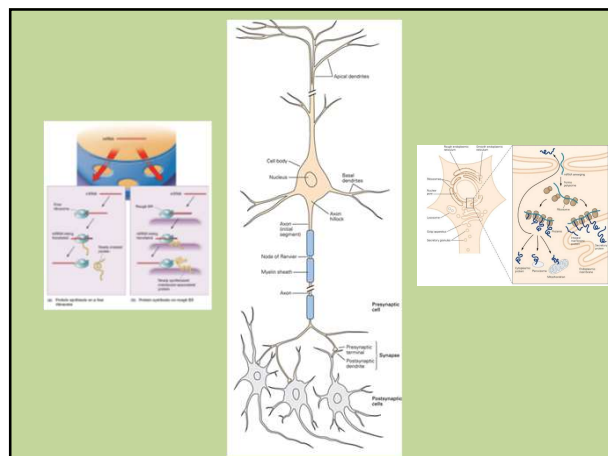
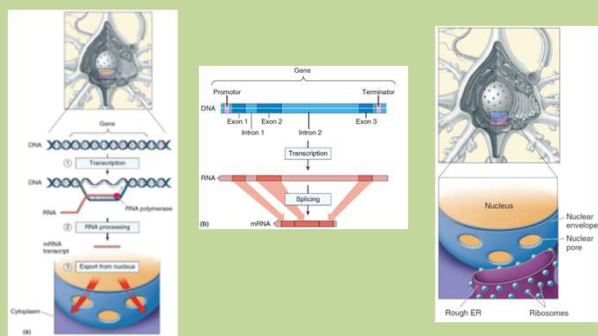
Electrical Properties of Neurons



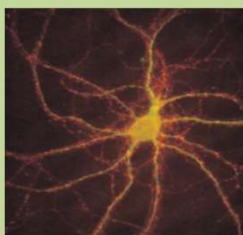
Cell Body (Soma)



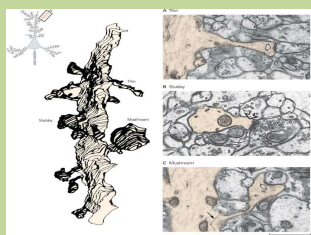
Protein Synthesis



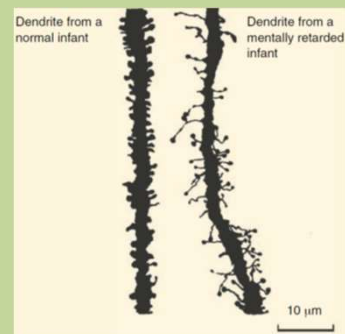
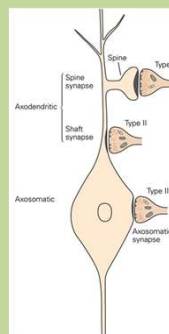
Dendrites



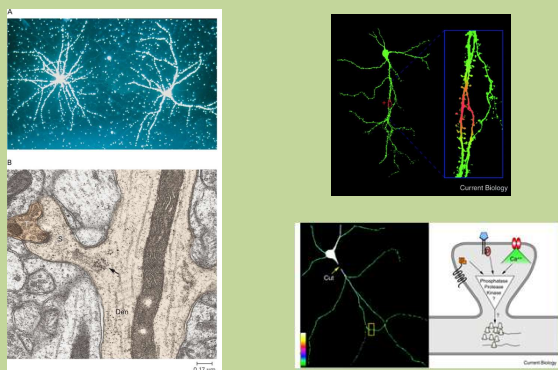
Dendritic Spines



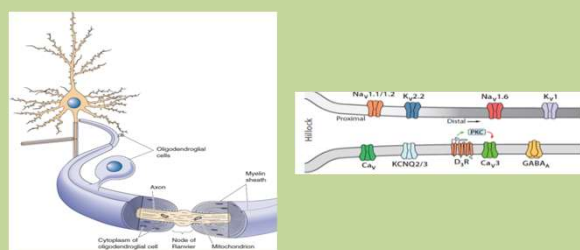
Function of Spines



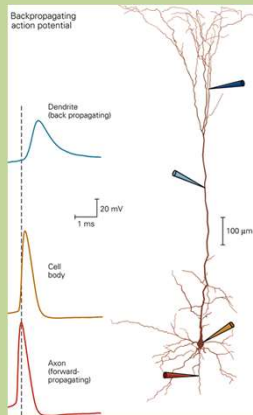
Local Protein Synthesis in Dendrites



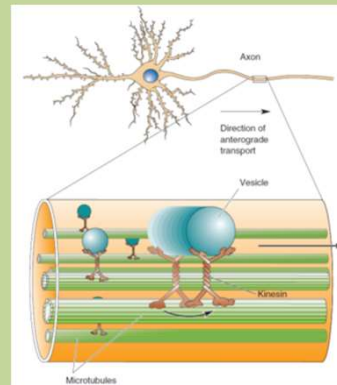
Axon



Generation of Action Potentials



Axoplasmic Transport



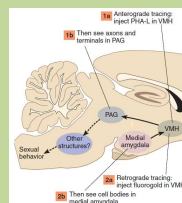
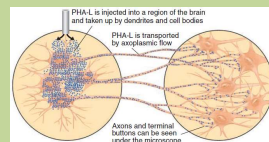
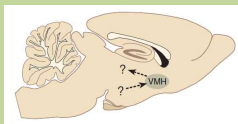
Anterograde Transport

Direction: Soma to terminal
Motor: kinesin

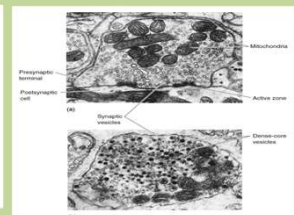
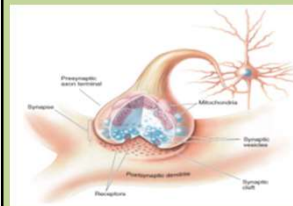
Retrograde Transport

Direction: terminal to soma
Motor: dynein

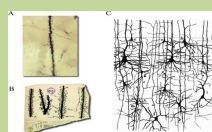
Tracing the Brain



Axon Terminals

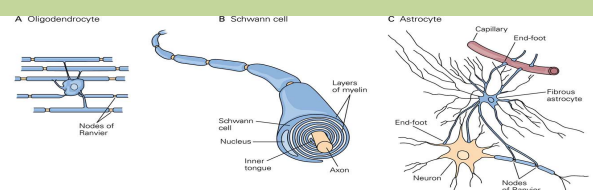


Glia



1. More abundant/10-fold;
2. Scaffold for supporting;
3. Uptake neurotransmitter near synaptic cleft;
4. Maintaining ionic environment;
5. Insulating neurons;
6. Nurturing, supplying metabolic components;
7. Scavenger to remove cellular debris;
8. Others.

Types of Glia Cells



Difference between nervous and endocrine systems

Feature	Nervous System	Endocrine System
Signals	electrical impulses (action potentials)	chemical impulses (hormones)
Pathways	transmission by neurons	transported by blood
Speed of information	fast	slow
Duration of effect	short lived	short or long lived
Type of action and response	voluntary or involuntary	always involuntary
Target	localized (cells connected to neuron)	often distant (many cells can be effected)