讨论课

1. 能在极端环境下生活的生物（如深海鱼、水熊虫）的特性，对材料科学有什么启发？

2. 转基因猪用于人类器官移植，有哪些进展和挑战？

3. 有的动物毒素非常危险甚至致命，但它们也可以为我们所用。试举例说明。

4. 抑郁症的症状有哪些？请简要概括目前的诊断和治疗方法，并讨论其局限性。

5. 阿尔茨海默症的症状有哪些？请简要概括目前的诊断和治疗方法，并讨论其局限性。

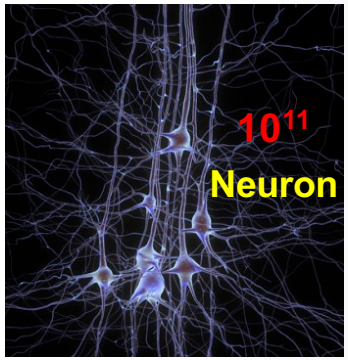
6. 精神分裂症的症状有哪些？请简要概括目前的诊断和治疗方法，并讨论其局限性。

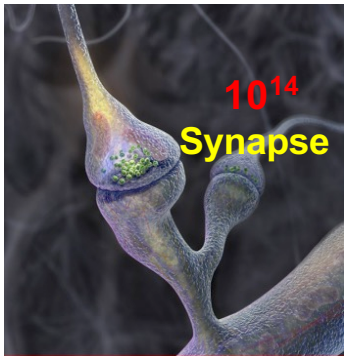
Nervous Systems

Yang Yang, PhD

Outline

- Brain 大脑
  - Anatomy and function
- Neuron 神经元
  - Structure: dendrite and axon
  - Function: resting and action potential
- Synapse 突触
  - Signal transduction
  - Synaptic plasticity



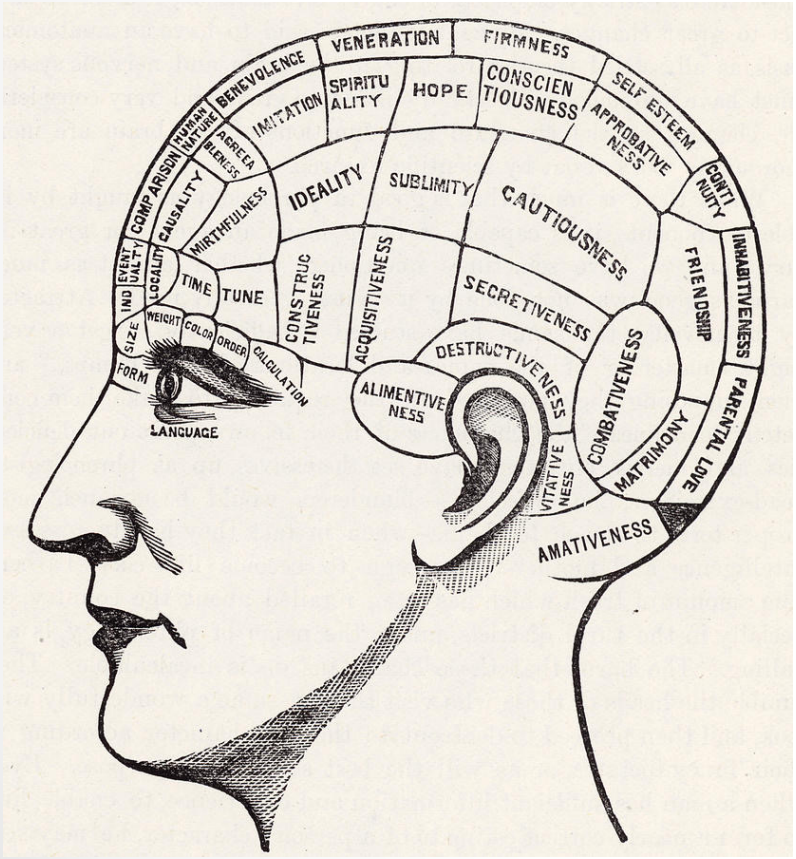


Outline

- Brain 大脑
  - Anatomy and function
- Neuron 神经元
  - Structure: dendrite and axon
  - Function: resting and action potential
- Synapse 突触
  - Signal transduction
  - Synaptic plasticity

Brain: anatomy and function

Phrenology 颅相学

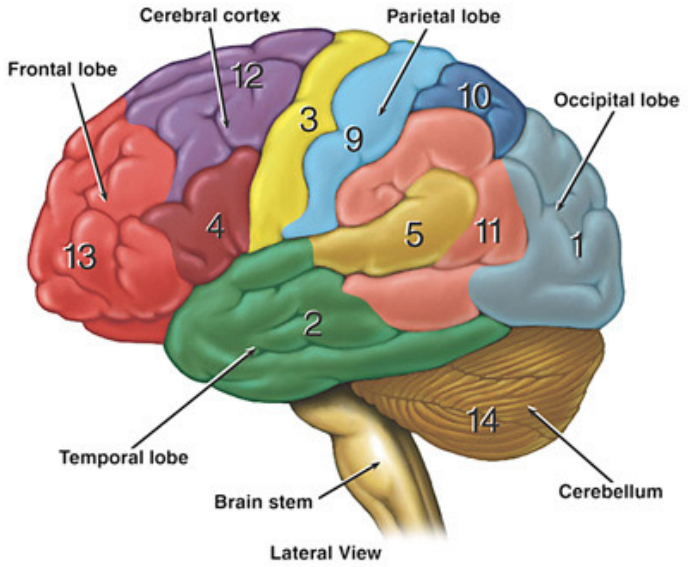


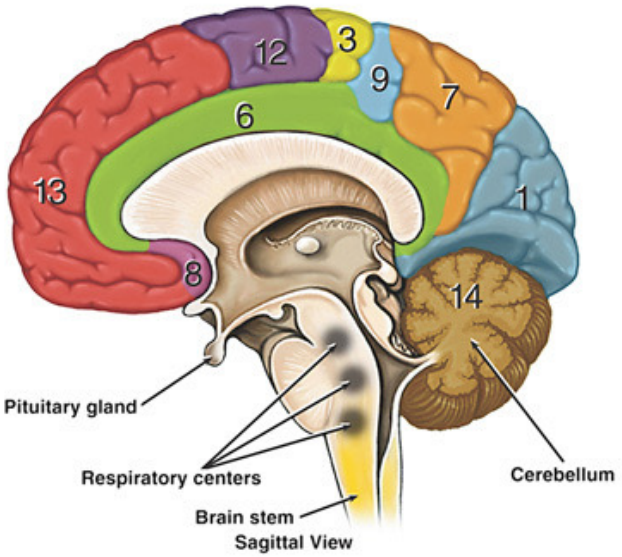
Functional Areas of the Cerebral Cortex

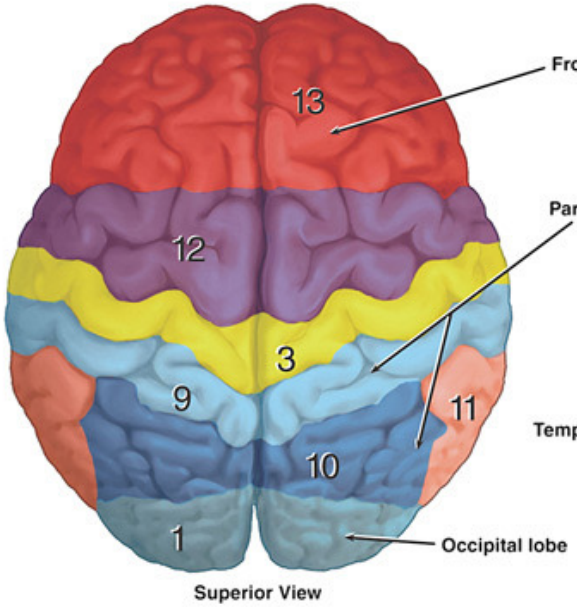
1. **Visual Area:**
   Sight
   Image recognition
   Image perception
2. **Association Area**
   Short-term memory
   Equilibrium
   Emotion
3. **Motor Function Area**
   Initiation of voluntary muscles
4. **Broca's Area**
   Muscles of speech
5. **Auditory Area**
   Hearing
6. **Emotional Area**
   Pain
   Hunger
   "Fight or flight" response
7. **Sensory Association Area**
8. **Olfactory Area**
   Smelling
9. **Sensory Area**
   Sensation from muscles and skin
10. **Somatosensory Association Area**
    Evaluation of weight, texture, temperature, etc. for object recognition
11. **Wernicke's Area**
    Written and spoken language comprehension
12. **Motor Function Area**
    Eye movement and orientation
13. **Higher Mental Functions**
    Concentration
    Planning
    Judgment
    Emotional expression
    Creativity
    Inhibition

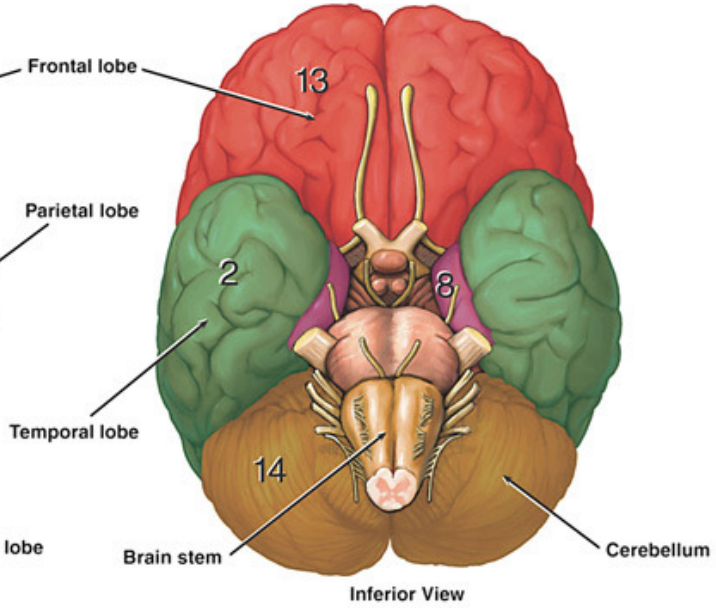
Functional Areas of the Cerebellum

14. **Motor Functions**
    Coordination of movement
    Balance and equilibrium
    Posture



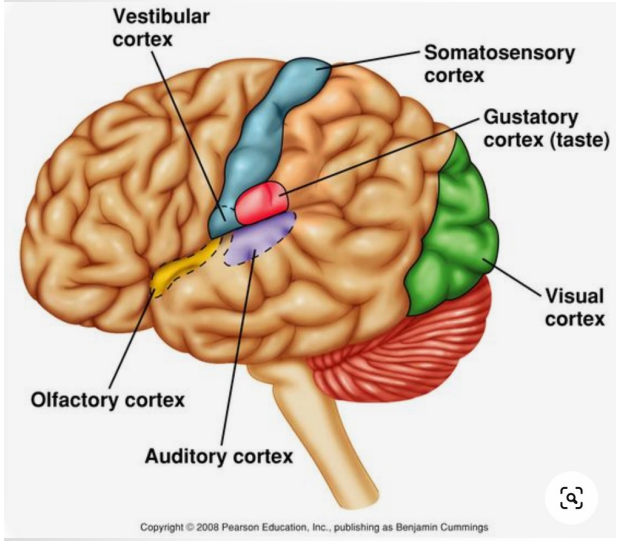


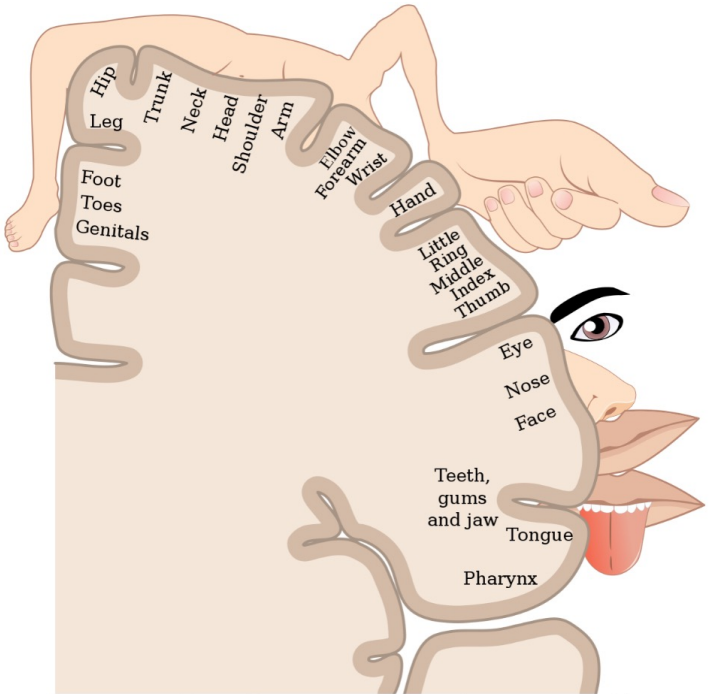




Dana Foundation

Somatosensory 躯体感觉





wikipedia.com

homunculus

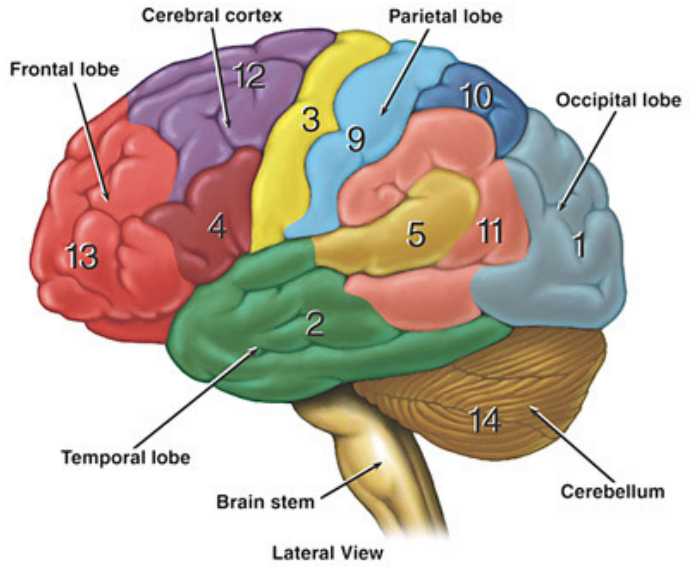
amazon.com

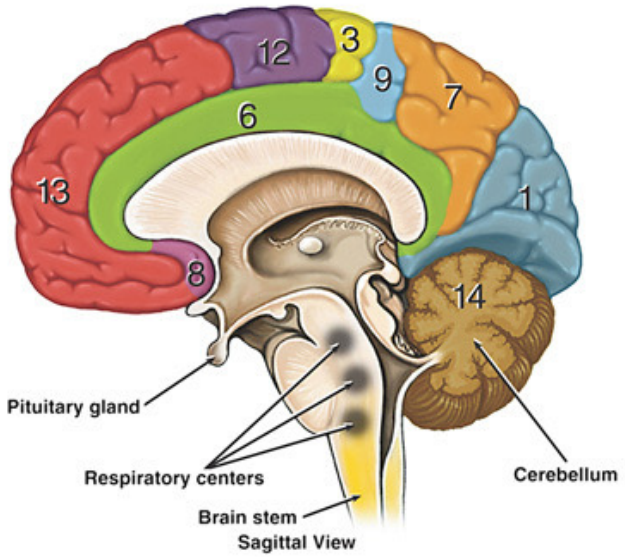
Functional Areas of the Cerebral Cortex

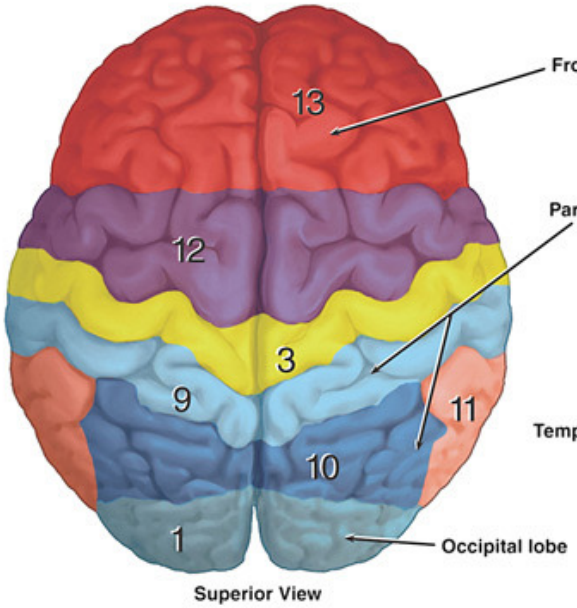
1. **Visual Area:**
   Sight
   Image recognition
   Image perception
2. **Association Area**
   Short-term memory
   Equilibrium
   Emotion
3. **Motor Function Area**
   Initiation of voluntary muscles
4. **Broca's Area**
   Muscles of speech
5. **Auditory Area**
   Hearing
6. **Emotional Area**
   Pain
   Hunger
   "Fight or flight" response
7. **Sensory Association Area**
8. **Olfactory Area**
   Smelling
9. **Sensory Area**
   Sensation from muscles and skin
10. **Somatosensory Association Area**
    Evaluation of weight, texture, temperature, etc. for object recognition
11. **Wernicke's Area**
    Written and spoken language comprehension
12. **Motor Function Area**
    Eye movement and orientation
13. **Higher Mental Functions**
    Concentration
    Planning
    Judgment
    Emotional expression
    Creativity
    Inhibition

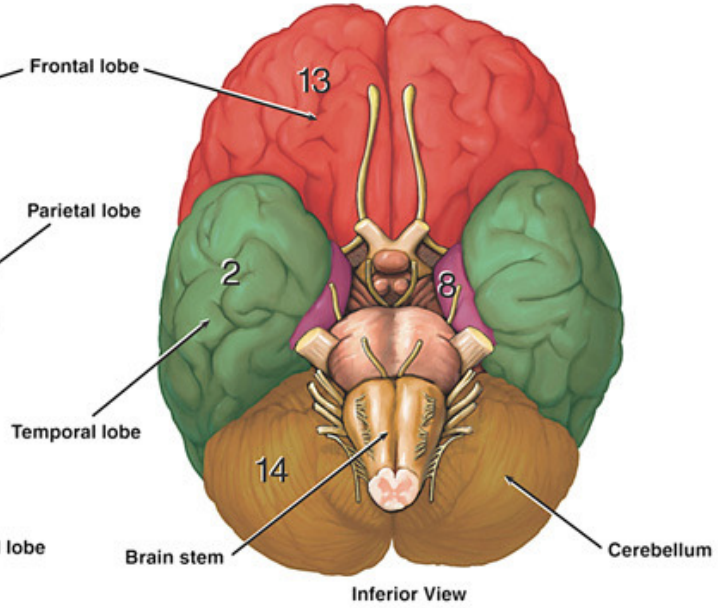
Functional Areas of the Cerebellum

14. **Motor Functions**
    Coordination of movement
    Balance and equilibrium
    Posture







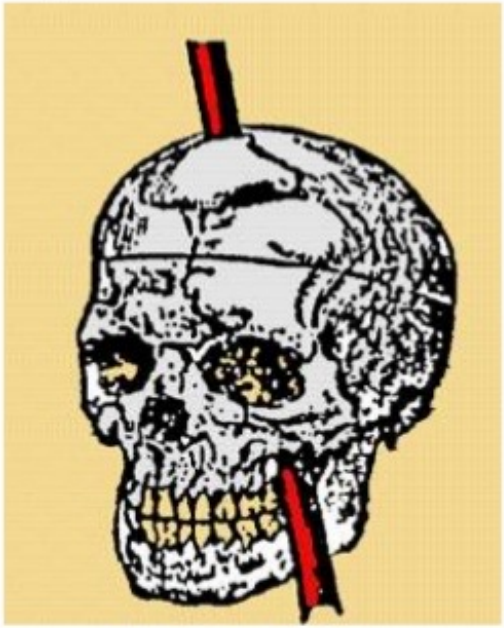


Dana Foundation

Prefrontal cortex 前额叶皮层
Higher cognitive functions

The Case of Phineas Gage (Harlow 1868)

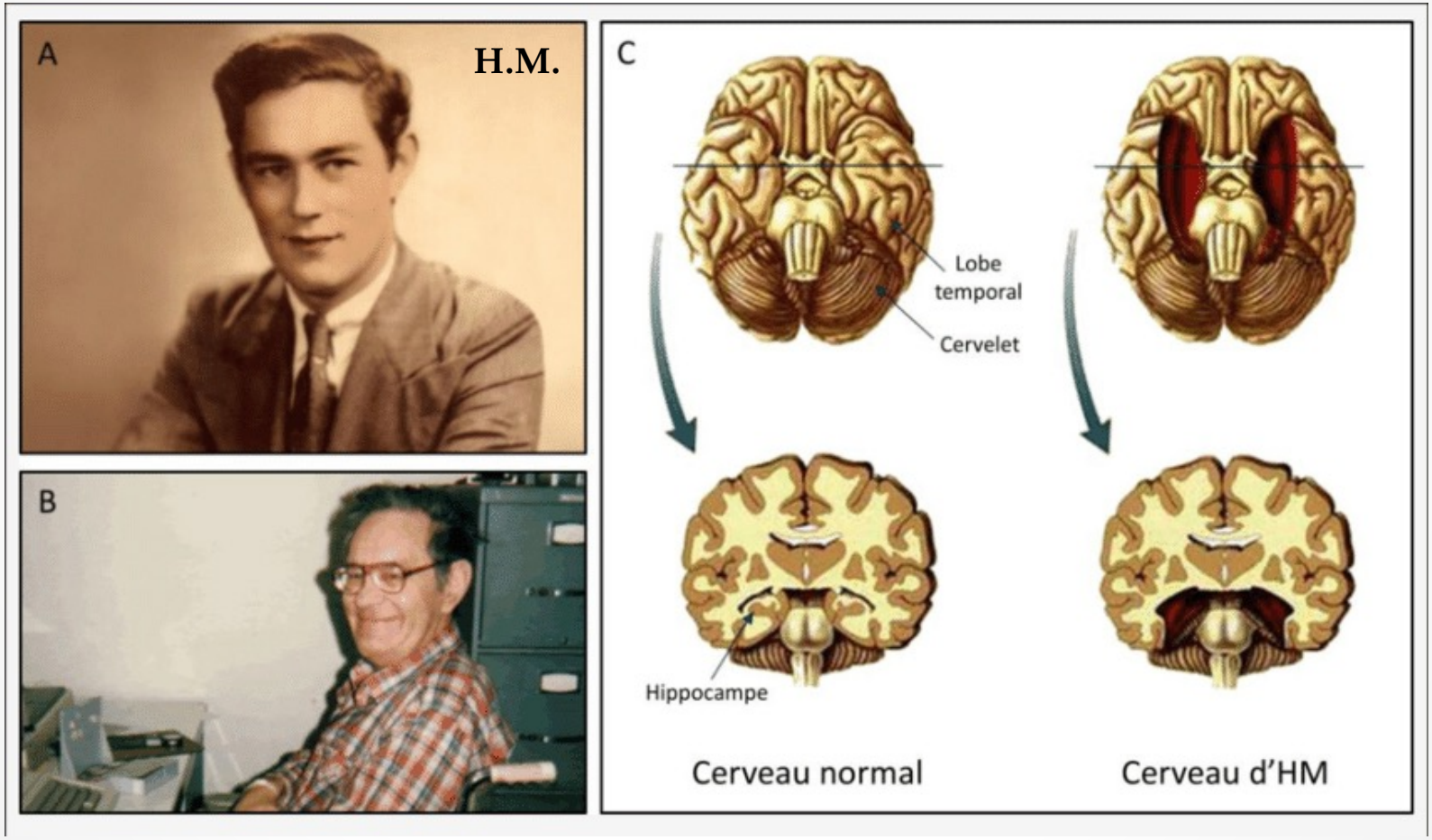
- Tamping iron blown through skull: L frontal brain injury
- Excellent physical recovery
- Dramatic personality change 'no longer Gage': stubborn, lacked in consideration for others, had profane speech, failed to execute his plans



Grunge@YouTube


MEMENTO
SOME MEMORIES ARE BEST FORGOTTEN.
(Official Selection - Toronto Film Festival)
(Official Selection - Venice Film Festival)
(Official Selection - Sundance Film Festival)
GUY PEARCE CARRIE-ANNE MOSS JOE PANTOLIANO
MEMENTO
NEWMARKET
SUMMIT

Hippocampus 海马体

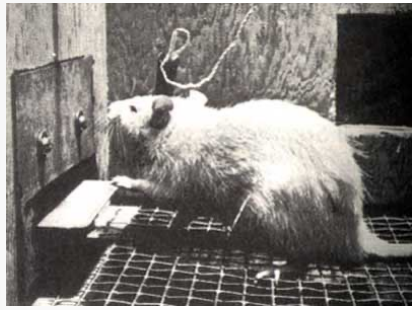


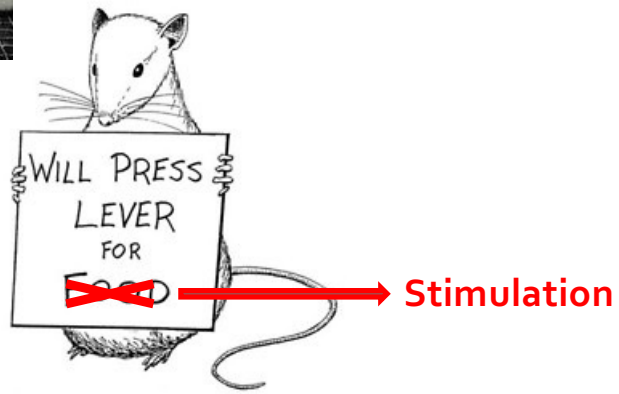
Brenda Milner

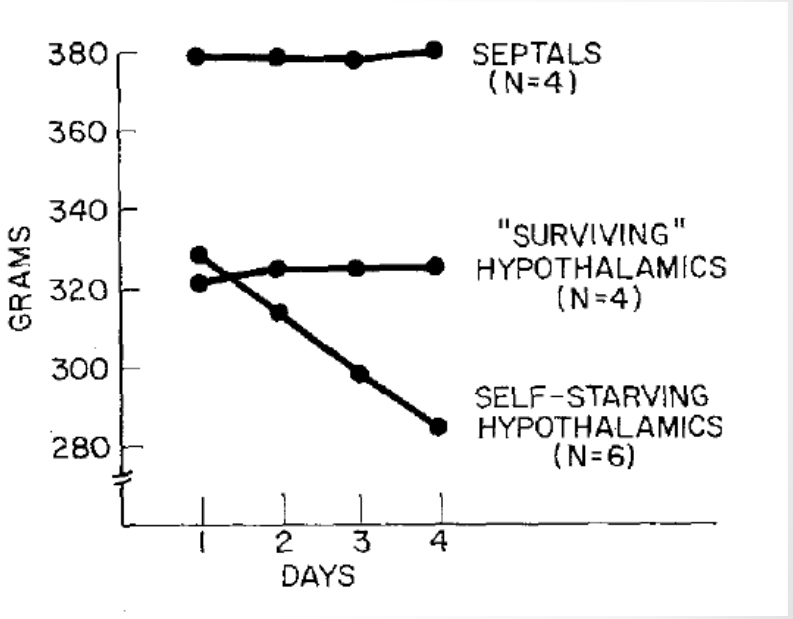
Patient H. M. (Henry Molaison)

Reward system

- Apparatus: Skinner box







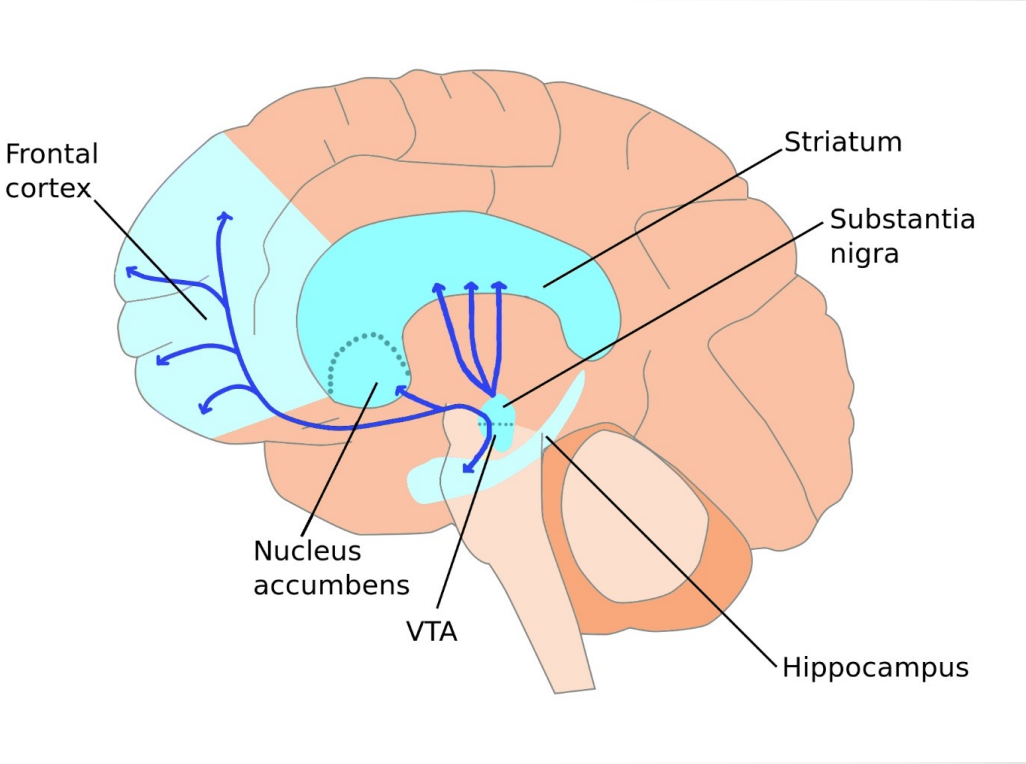
"Positive reinforcement produced by electrical stimulation of septal area and other regions of rat brain."

Olds and Milner, 1954

Routtenberg and Lindy 1965

Reward system: dopamine

- Ventral tegmental area (**VTA**) projects to Nucleus Accumbens (**NAc**)
- VTA projects to frontal cortex
- VTA releases **dopamine** 多巴胺
- Dopamine is also involved in motor control

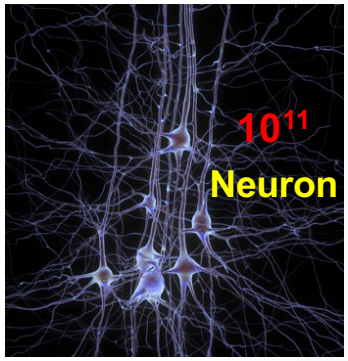


Wikipedia.com

Addiction

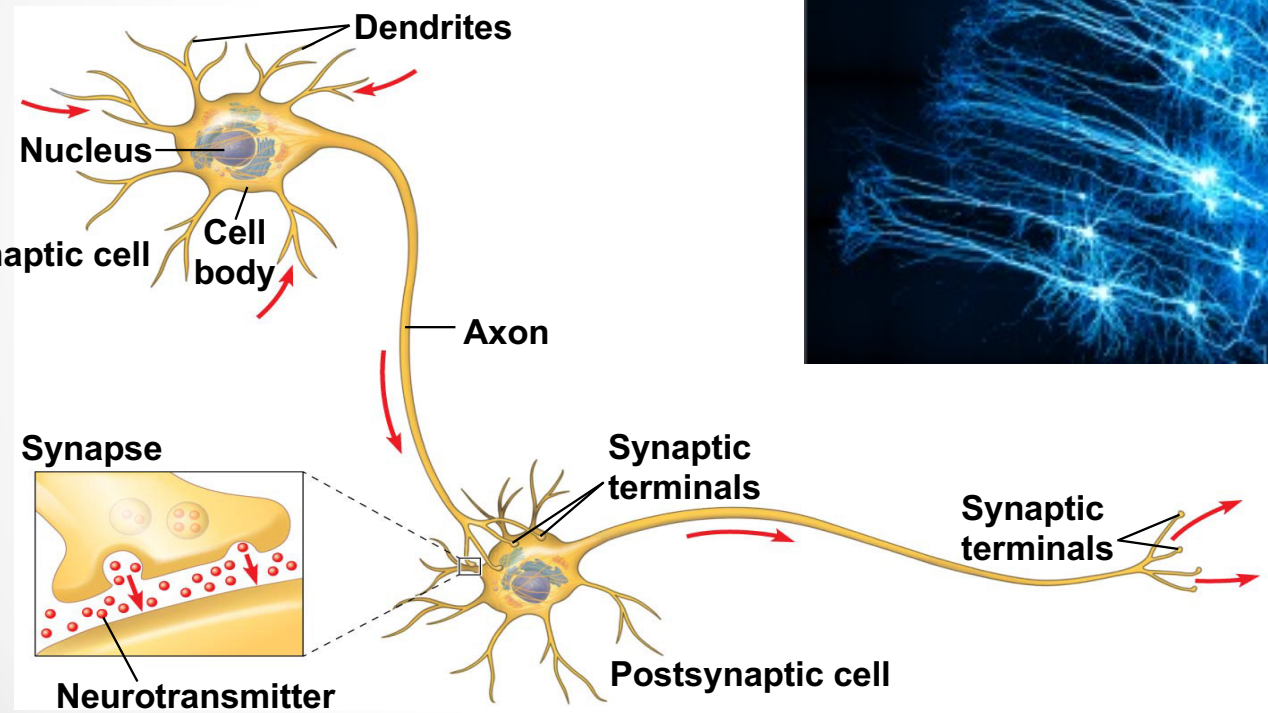
Outline

- Brain
  - Anatomy and function
- Neuron
  - Structure: dendrite and axon
  - Function: resting and action potential
- Synapse
  - Signal transduction
  - Synaptic plasticity



Neuron: Structure

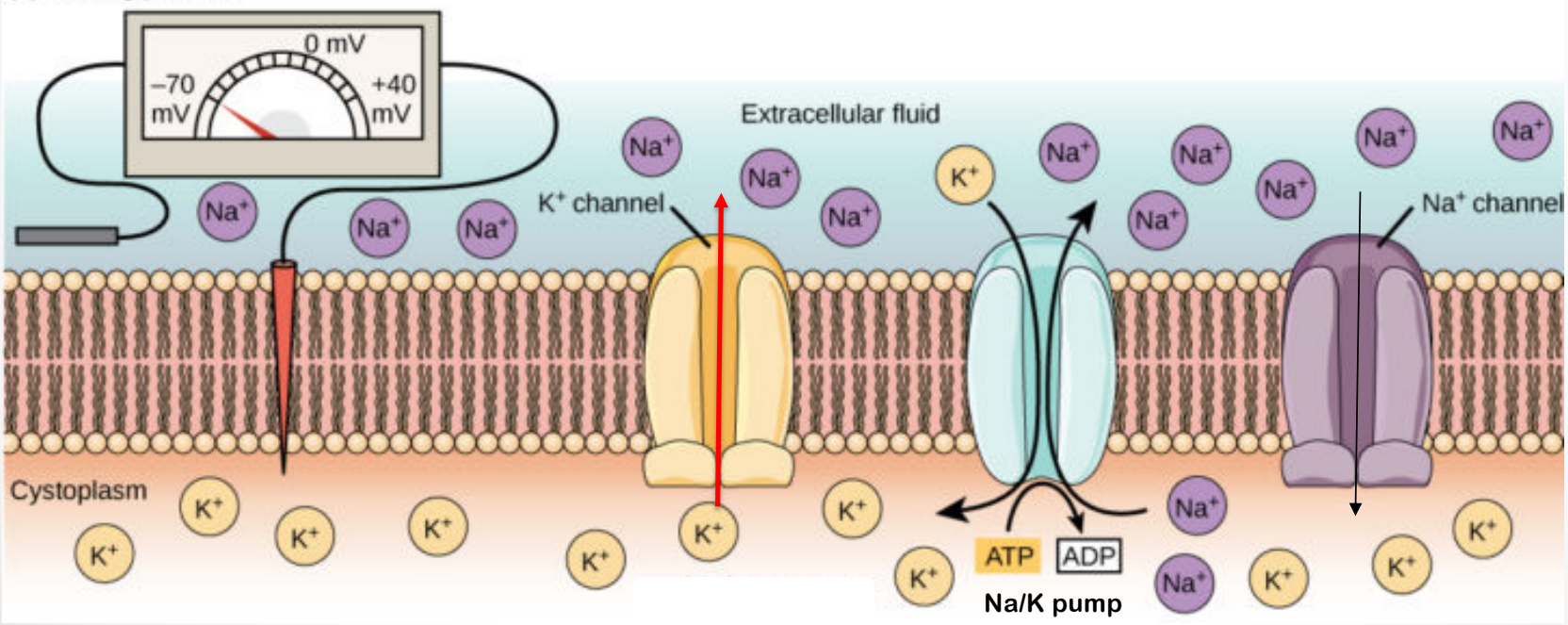
- **Dendrite 树突:** branched extensions that *receive* signals from other neurons
- **Axon 轴突:** a much longer extension that transmits signals to other neurons



The Scientist

Resting potential 静息电位

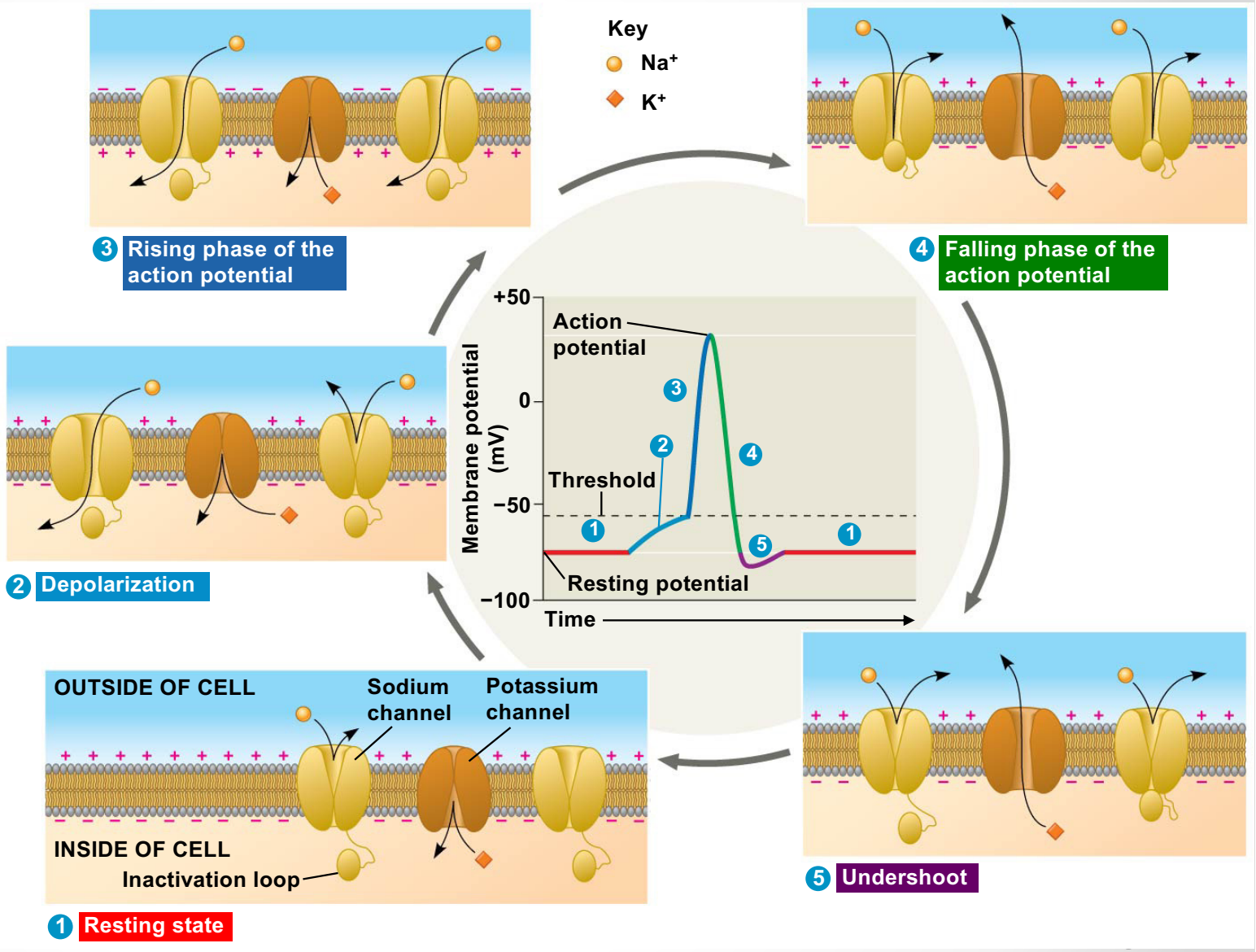
- Inside cell: High K^+, Low Na^+.
- Neuron at rest: **K^+ leak channels** open.
- Resting potential: around -70mV.



Action potential

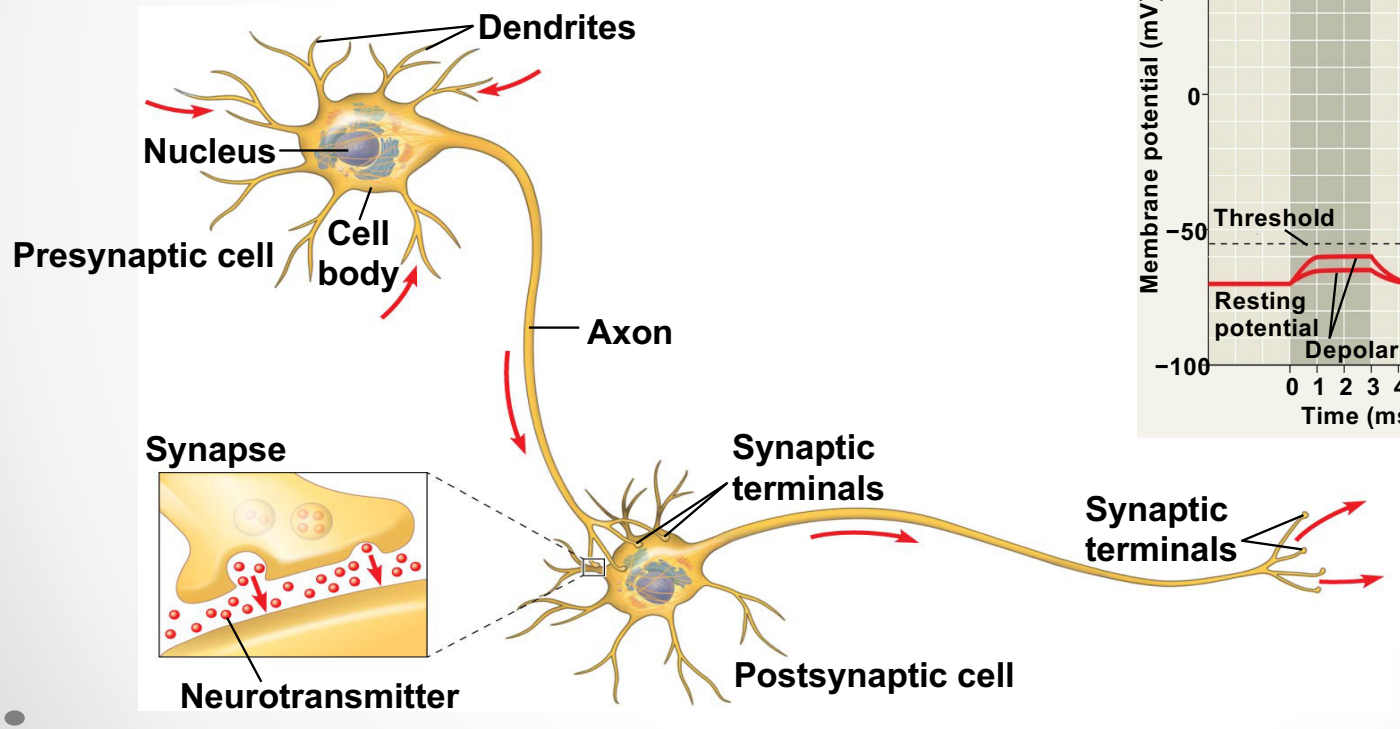
动作电位

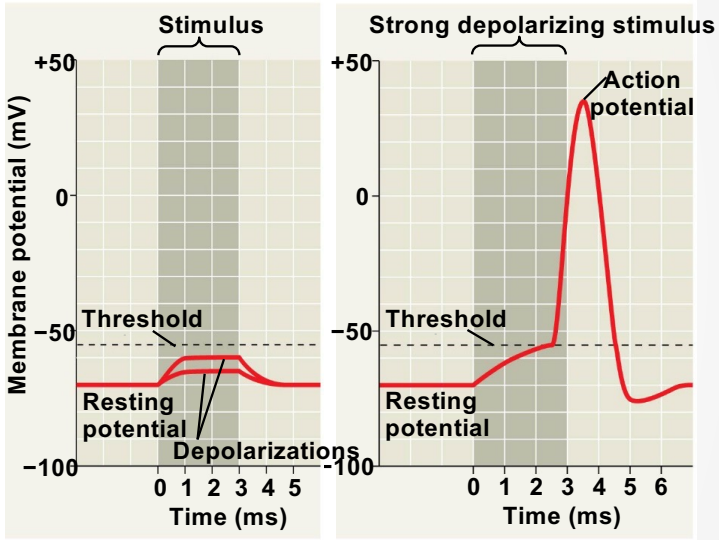
1. Most channels closed
2. Ligand-gated channels open
   配体门控通道打开
3. Voltage-gated Na^+ channels open 电压门控钠通道打开
4. Voltage-gated Na^+ channels inactivated; voltage-gated K^+ channels open电压门控钠通道失活，电压门控钾通道打开
5. *V*oltage-gated K^+ channels close and resting potential restored电压门控钾通道关闭



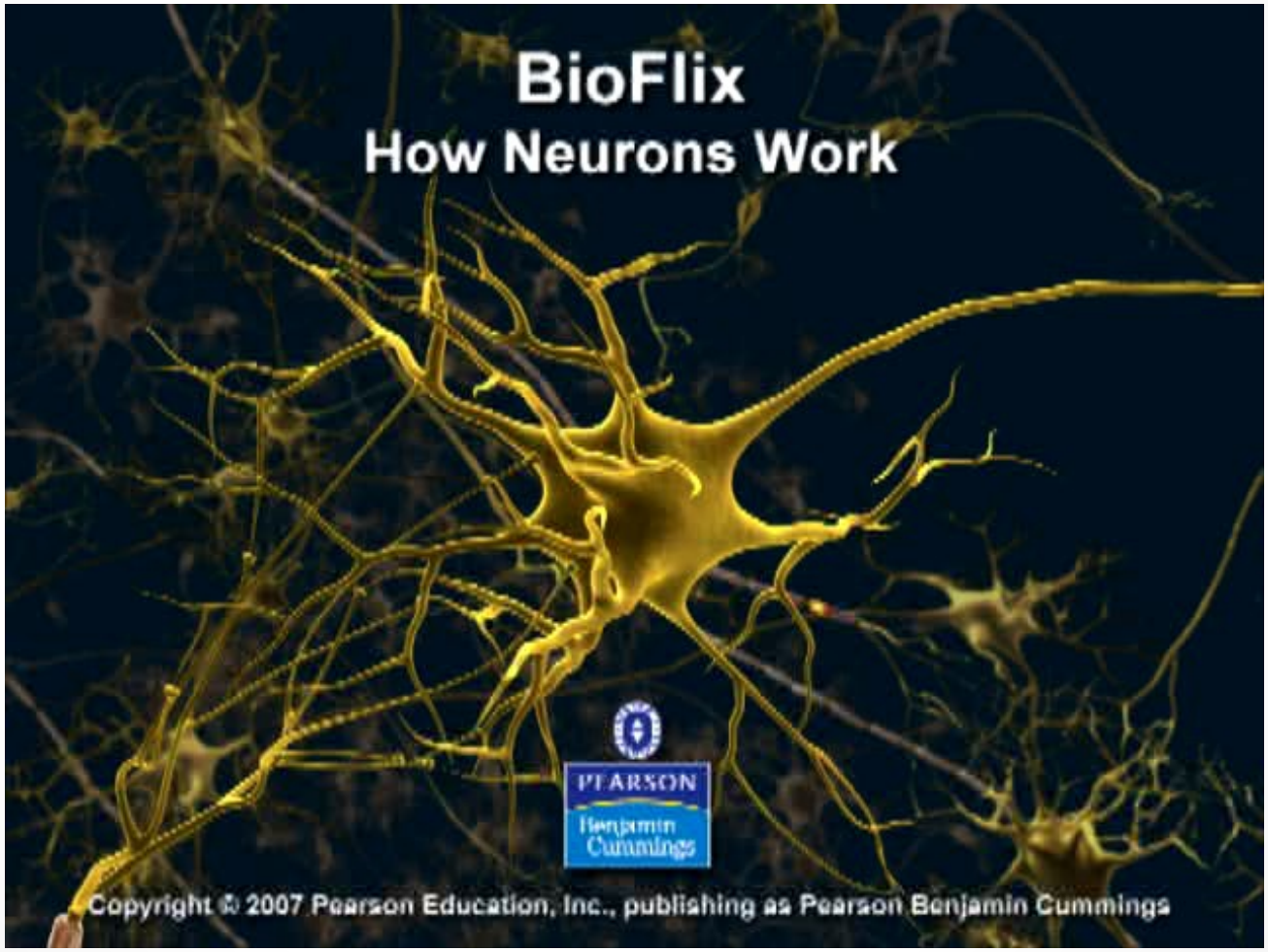
Signal transduction: Action Potentials

- **One direction:** presynaptic cell -> postsynaptic cell
- **All-or-none全或无**



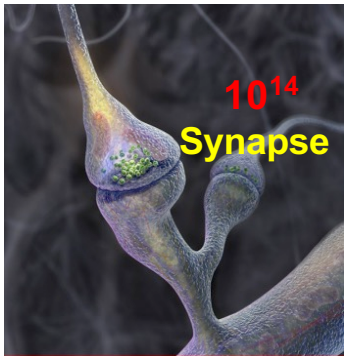


How Neurons Work



Outline

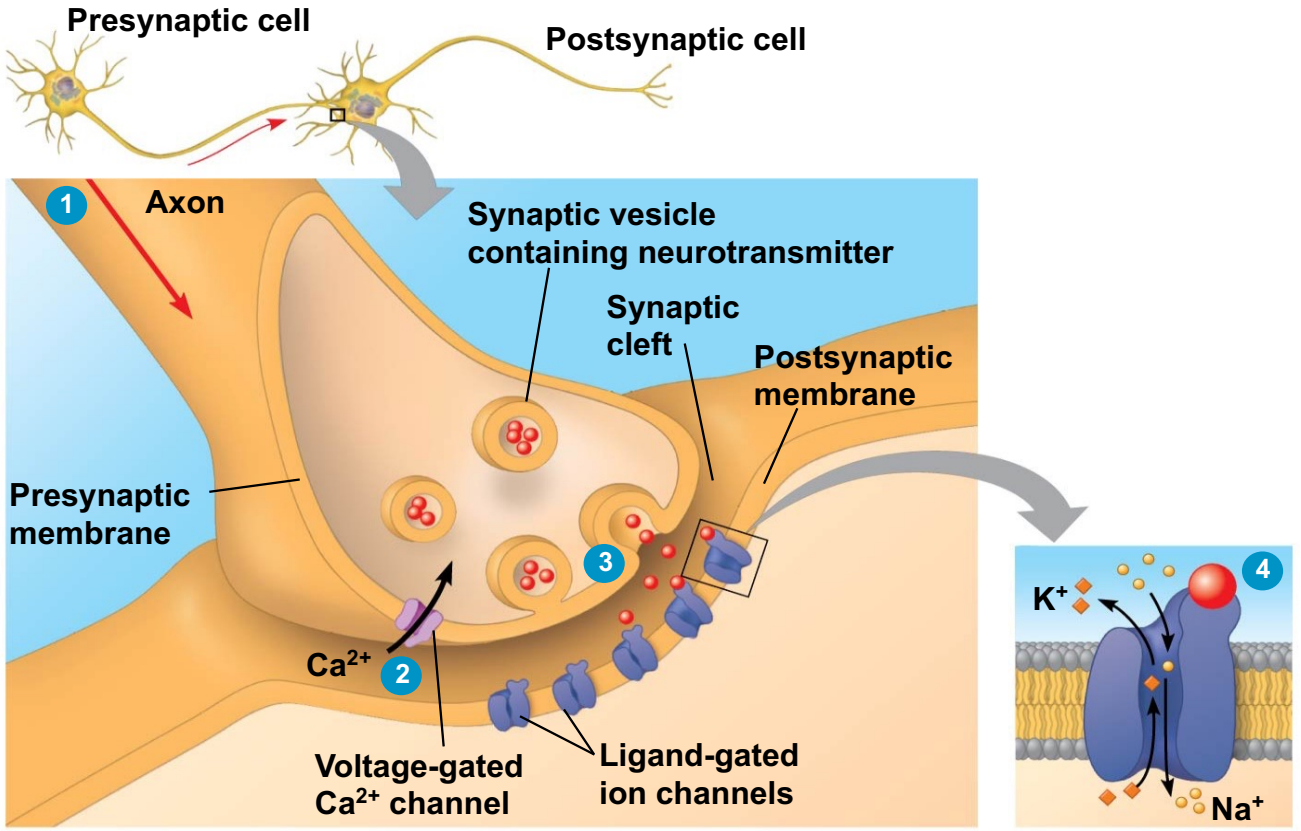
- Brain
  - Anatomy and function
- Neuron
  - Structure: dendrite and axon
  - Function: resting and action potential
- Synapse
  - Signal transduction
  - Synaptic plasticity



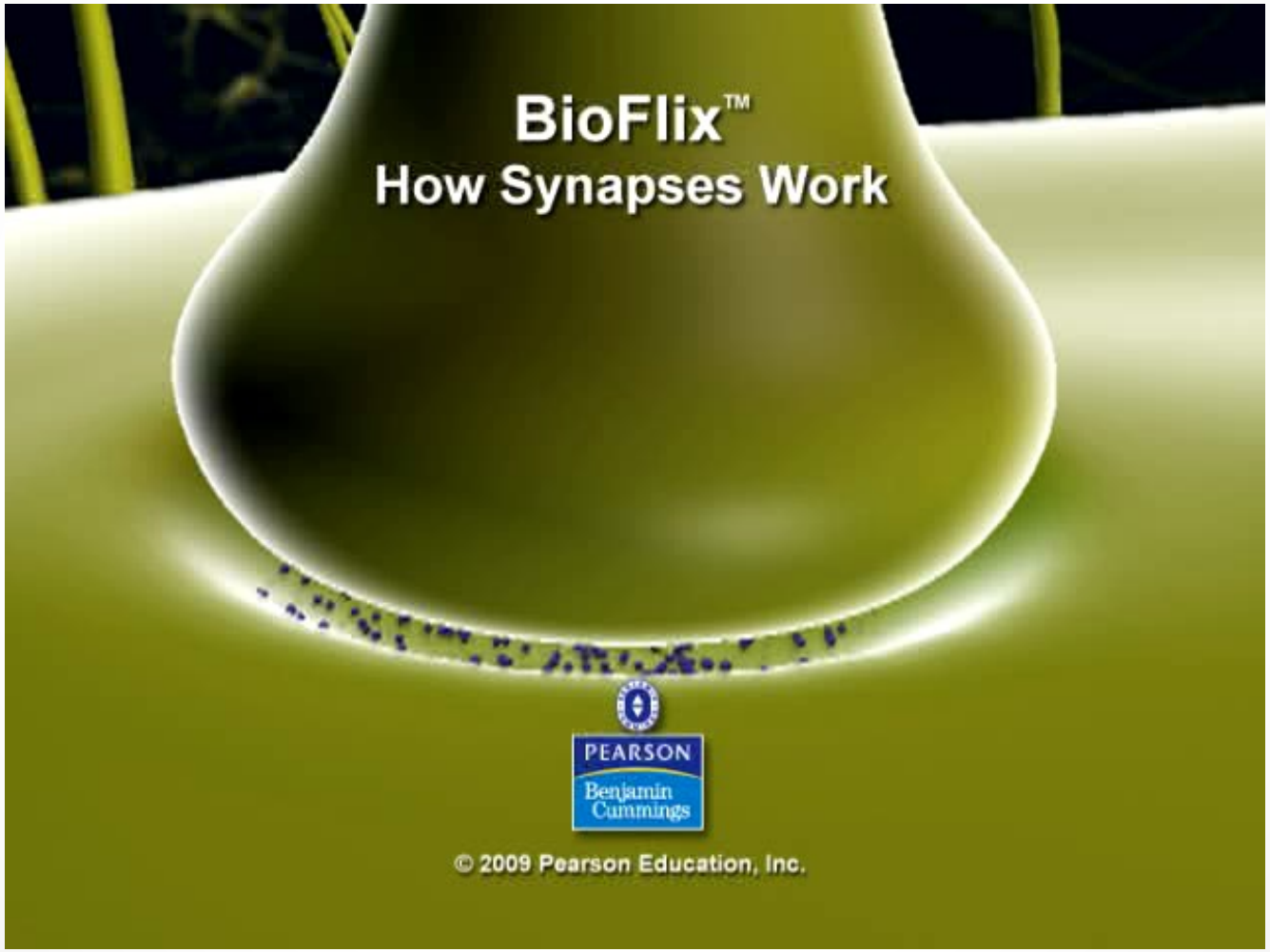
Synaptic transmission

- Presynaptic action potential opens **voltage-gated calcium channels**, leading to **neurotransmitter release** 神经递质释放

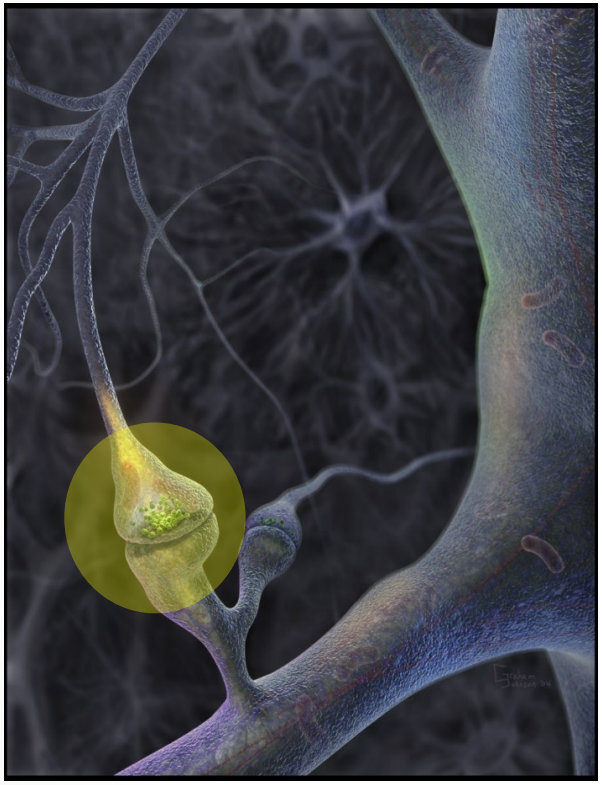
- Binding of neurotransmitters causes **ligand-gated ion channels** 配体门控离子通道 in the postsynaptic cell to open, generating a postsynaptic potential (excitatory or inhibitory)



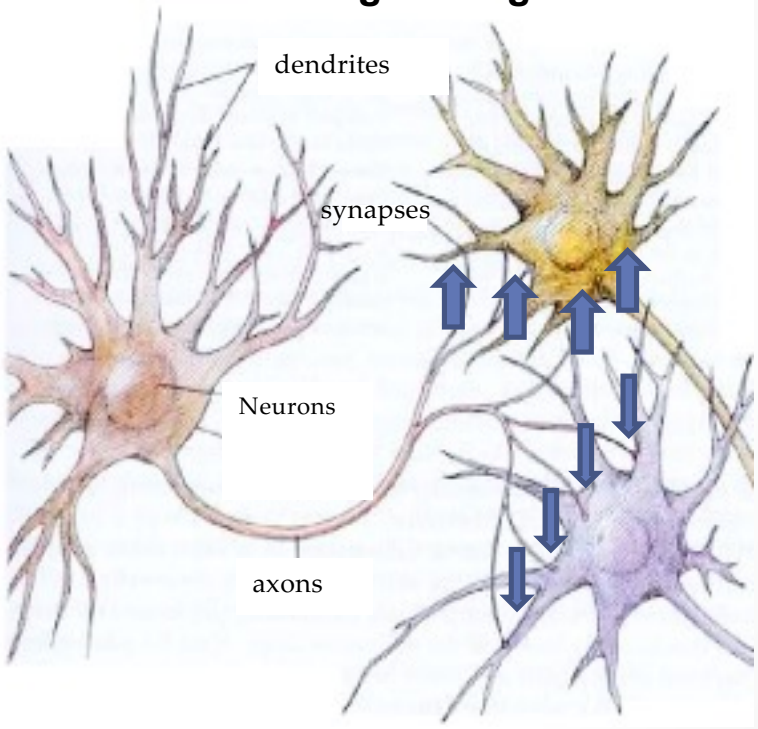
How Synapses Work



Synaptic plasticity: neural basis of learning



Strengthening or addition of synapses



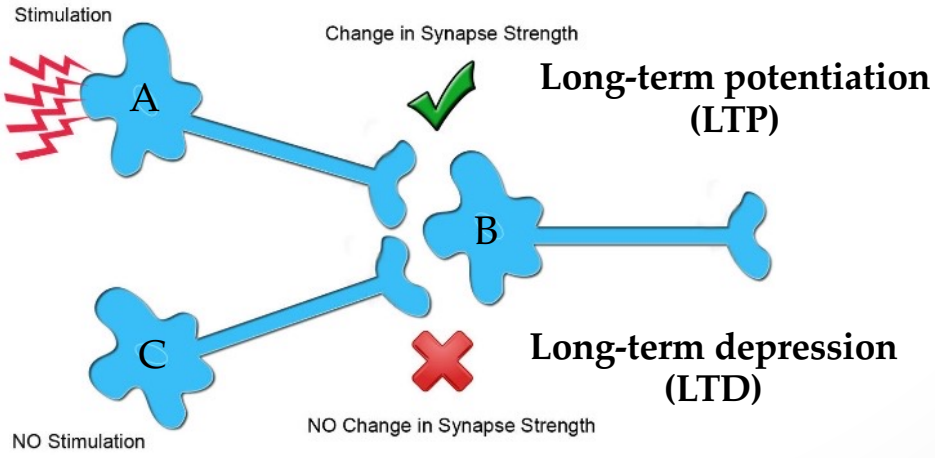
weakening or elimination of synapses

Synaptic plasticity: Hebbian theory

- Hebb's postulate
  - **Donald Hebb**, 1949: "*When an axon of cell A … excite(s) cell B and repeatedly or persistently takes part in firing it,* ***some growth process or metabolic change takes place*** *such that A's efficiency, as one of the cells firing B, is increased.*"

    (**Fire together, wire together**)

Donald O. Hebb
1904-1985



Synaptic plasticity and learning