

AP Biology

Chapter 48 - Neurons, Synapses, and Signaling

Name _____

Gah! I HATE Reading The Overview!

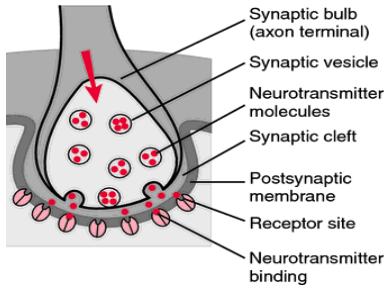
The function of the neuron, stated as briefly as possible, is to _____.

Are neural electrical signals long-distance or short-distance? _____

Are neural chemical signals long-distance or short-distance? _____

Are signals that travel the length of a neuron electrical or chemical? _____

Are signals that travel from one neuron to the next electrical or chemical? _____



In the diagram to the left, **circle** the icon that represents an electrical signal. OK, now **circle** the icons that represent a chemical signal.

A simple cluster of neurons is called a _____.

A large group of neurons is called a _____.

In this chapter, we'll examine the structure of a _____.

Concept 48.1: Neuron Organization And Structure Reflect Function In Information Transfer

What are the three stages of information processing in animals?

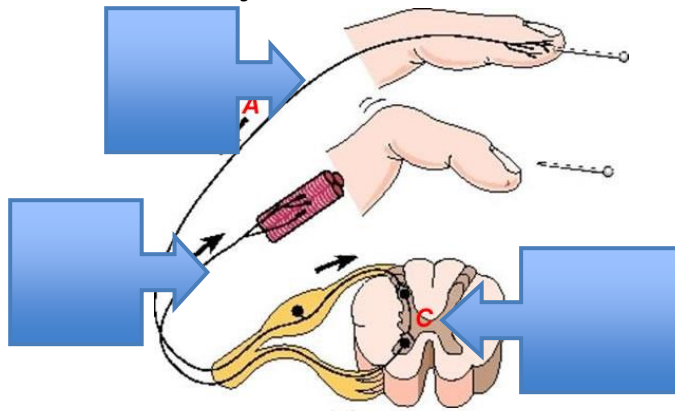
- 1.
- 2.
- 3.

Integration occurs in the _____ nervous system

The nerves found outside of the CNS constitute the _____ nervous system

A bundle of neurons is called a _____.

In the diagram below, label a **sensory neuron**, an **interneuron**, and a **motor neuron**.

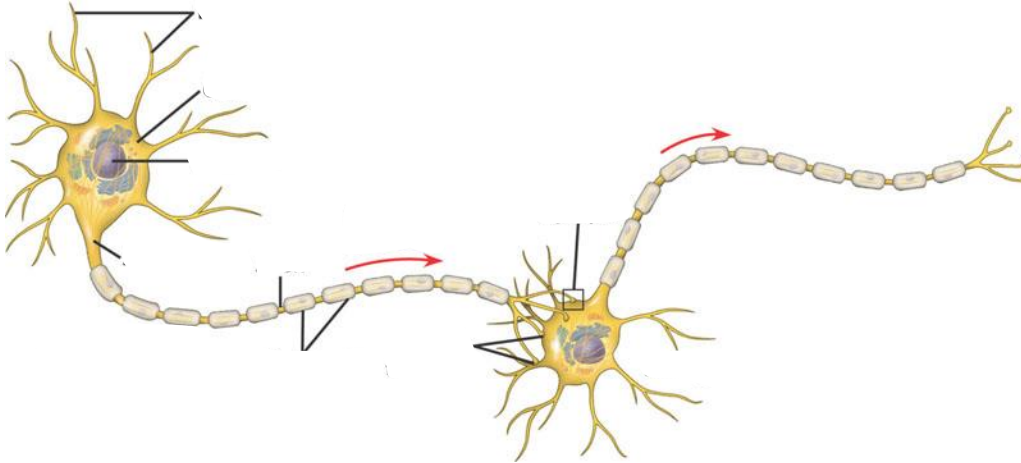


Neuron Matching

- | | |
|-------------------|----------------------------------------------------|
| S. Sensory Neuron | _____ 1. Transmit information toward interneurons. |
| I. Interneuron | _____ 2. The vast majority of neurons |
| M. Motor Neuron | _____ 3. Detect external stimuli |
| | _____ 4. Transmit signals to muscle cells |
| | _____ 5. Analyze and interpret |
| | _____ 6. Trigger gland activity |

Neuron Structure and Function

Is a neuron a *specialized* cell or a *generalized* cell? _____



Label:

Dendrites
Cell Body
Nucleus
Axon hillock
Presynaptic cell
Axon
Signal direction
Synaptic terminals
Postsynaptic cell
Synapse

In a single neuron:

- _____ Are there **multiple** dendrites or is there a **single** dendrite?
 _____ Are there **multiple** axons or is there a **single** axon?
 _____ Can a signal (impulse) go in **both** directions or in **one direction** only?
 _____ Which transmits signals to other cells: the **axon** or the **dendrite**?
 _____ Which is significantly longer, the **axon** or the **dendrite**?

Other Questions:

- _____ What is the name of the cell junction at the end of the axon?
 _____ What are the three cell types that can receive a neural signal?

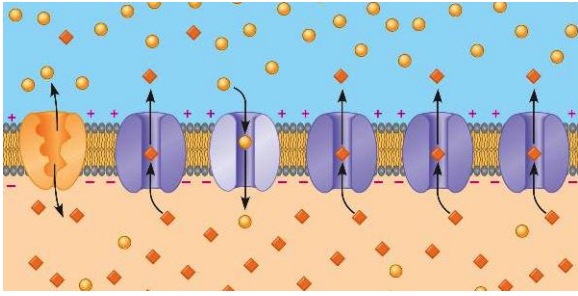
 _____ Is a neurotransmitter **electrical** or **chemical**?
 _____ Which cell type secretes the neurotransmitter: **presynaptic** or **postsynaptic**?
 _____ In order to transmit signals to many cells, an _____ (axon / dendrite) must be highly branched.
 _____ The greatest number of synapses are found in _____ (motor / inter / sensory) neurons.
 _____ Cells that "take care of" neurons are called _____ cells, or _____.
 _____ In the vertebrate animal body, are there more **glial cells** or more **neurons**?

Concept 48.2 Ion Pumps And Ion Channels Establish The Resting Potential Of A Neuron

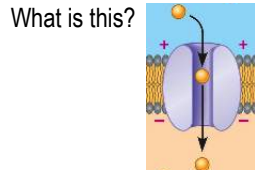
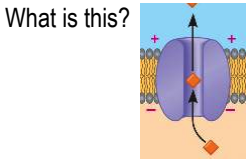
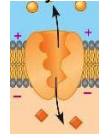
Do most cells maintain ion concentrations that are **imbalanced** or **isotonic** with the fluid that surrounds them? _____
 The inside of a neuron is _____ (**negatively** / **positively**) charged.
 The charge differential between the outside and inside of a neuron is called the m_____ p_____.
 The membrane potential of a resting (non-conducting) neuron is between _____ and _____ mV.
 What are the two signals that can cause a change in this internal negative charge?
 1.
 2.
 It is only when the membrane potential CHANGES that we are able to _____ a shark, _____ a frisbee, and
 _____ a fur coat.

The Resting Potential

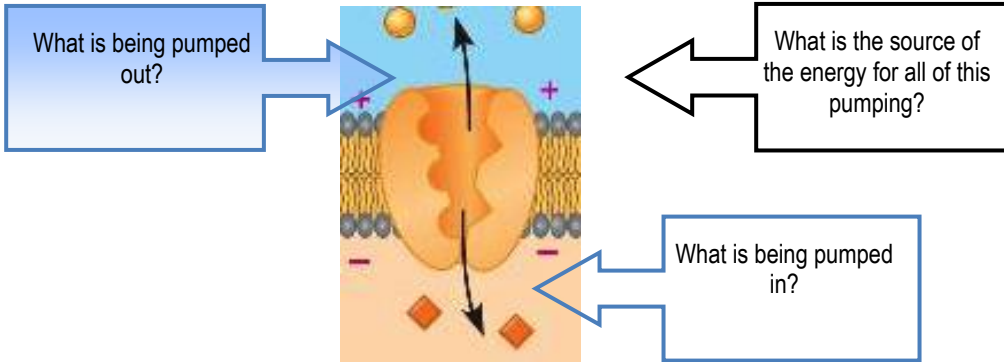
The two ions that play an important role in electric potentials in neurons are BOTH _____ charged.
 They are, of course, the two elements _____ and _____.
 From what food source do YOU get most of your potassium? _____ How about most of your sodium? _____



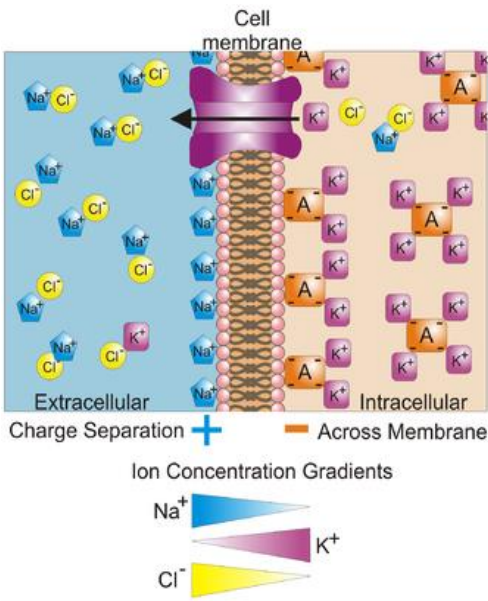
What is the overall charge of the outside of the cell? _____
 What is the overall charge of the inside of the cell? _____
 Where is sodium more highly concentrated? _____
 Where is potassium more highly concentrated? _____
 What is the little symbol for sodium? _____
 What is the little symbol for potassium? _____
 What is this? _____



The Sodium-Potassium Pump



In addition to the potassium being concentrated on the outside of the neuron, there are also negatively charged _____ ions.
 In addition to the concentration of sodium on the inside of the neuron, there are also large _____ (many of them protein molecules).
 The sodium-potassium pump transports _____ (#) ions out of the cell for every _____ (#) potassium ions that it transports in.
 Are ion channels selective, or do they allow the entry/exit of any form of ion? _____



Potassium ions are concentrated on the _____ of the cell.
 Sodium ions are concentrated on the _____ of the cell.
 Chloride ions are concentrated on the _____ of the cell.
 Large anions are concentrated on the _____ of the cell.
 The overall charge of the outside of the cell is _____.
 The overall charge of the inside of the cell is _____.
 According to your textbook, are gated sodium channels usually closed or open?
 According to your textbook, are gated potassium channels usually closed or open?
 The net flow of K⁺ out of a neuron proceeds until _____

In this model, is there a chloride ion channel? _____ (Yes / No)
 Why don't the anions escape to the outside of the neuron?
 Potassium ions will flow out of the cell until the c _____ of potassium ions inside of the cell is balanced by the repulsion of potassium by _____ ions on the outside of the cell.

48.3 Action Potentials are the signals conducted by axons.

Action Potentials

The change in membrane permeability to particular ions is due to the o_____ and c_____ of gated ion channels that then alters the membrane p_____.

Ion Matching: Match the ion (in the yellow textbox) with the term or effect (in the green textbox)

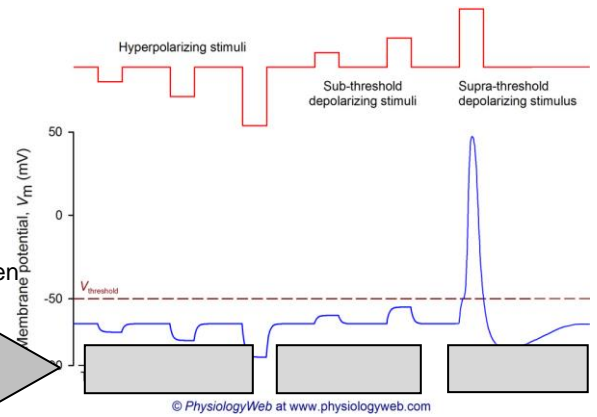
Ions
K+
Na+

Terms or Effect
____ Found outside cell when at rest
____ Found inside cell when at rest
____ Cell becomes + as it moves by diffusion when gated channels open
____ Cell becomes - as it moves by diffusion when gated channels open
____ Hyperpolarization
____ Depolarization

Graded Potential or Action Potential????????????

- _____ Involve voltage gated ion channels
- _____ Depolarization must reach the threshold
- _____ Shift in membrane potential that varies in magnitude
- _____ Decay with distance from their source
- _____ Constant magnitude and regenerate in adjacent regions of the membrane.
- _____ Effect on generation of nerve signal
- _____ Increased depolarization causes more sodium gates to open
- _____ All or none response

These three as well! →



Membrane depolarization opens _____ types of channels but they respond i_____ and s_____. S_____ channels open _____, initiating an action potential. As an action potential proceeds the sodium channels are i_____ until the membrane returns to r_____ p_____. P_____ channels open more s_____ than sodium but remain _____ until the end of the action potential.

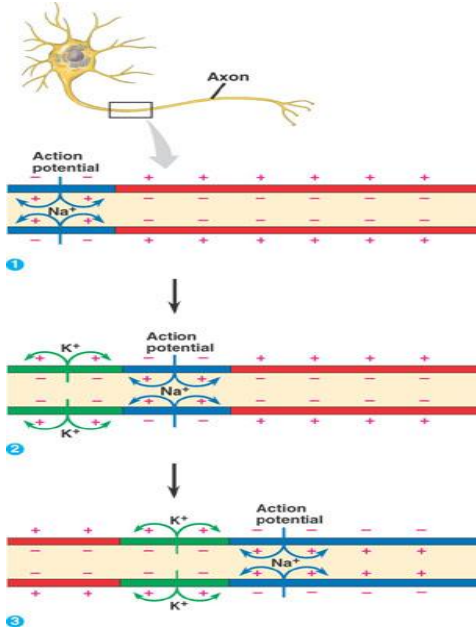
Sequence the following steps that occur during an action potential*: (reference Figure 48.11)

- | | |
|---------------------------------------------------------------------|------------------------------------------------|
| _____ Positive feedback brings membrane potential close to E_{Na} | _____ Membrane potential brought back to E_K |
| _____ Membrane permeability to K^+ higher than at rest | _____ 1 Stimulus depolarizes membrane |
| _____ Threshold is crossed | _____ K^+ ions diffuse out of the cell |
| _____ Most voltage gated K^+ channels open | _____ Voltage gated Na^+ channels inactivate |
| _____ Na^+ channels open | _____ Gated K^+ channels close |
| _____ Membrane potential returns to resting potential | _____ Na^+ ions diffuse into the cell |
| _____ More depolarization occurs so more Na^+ channels open | |

***This is a very difficult exercise. One misstep has the potential to affect ALL of the answers that follow.**

_____ gates remain closed and therefore a second a_____ p_____ cannot be triggered during the refractory period. For most neurons the onset of an action potential and the end of the r_____ p_____ is only 1-2 m_____ so h_____ can be produced per second by a single neuron. Differences in action potential f_____ conveys information about s_____ of the signal. Mutations in the genes that encode i_____ c_____ p_____ can cause disorders such as m_____ affecting skeletal muscle and e_____ affecting the brain.

Conduction of Action Potentials



_____ An action Potential is usually initiated at _____.

_____ Na^+ flow creates an _____ and depolarizing neighboring region of axon membrane.

_____ The action potential is repeated _____ along length of axon.

_____ The action potential remains constant due to the _____ response.

_____ The nerve impulse moves from _____ to _____ the _____ like falling dominoes.

_____ Behind the depolarization zone is a zone of _____ preventing an action potential from moving back toward the cell body.

_____ The gates inactivated during repolarization are _____ gates.

Evolutionary Adaptations of Axon Structure

_____ Axon _____ is the major factor determining the **speed** of an action potential.

_____ A _____ axon will conduct an action potential **faster**.

_____ Invertebrate axon diameters are _____ for fast conduction while vertebrate axon diameters are narrower.

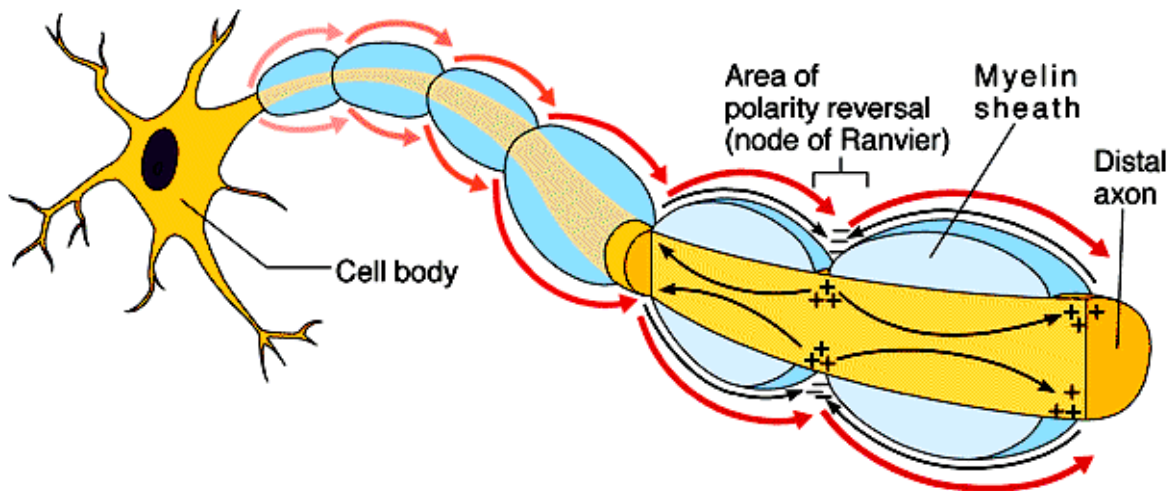
_____ Vertebrate axons have electrical insulation known as _____ that speeds up conduction

_____ the gaps between adjacent Schwann cells are called _____.

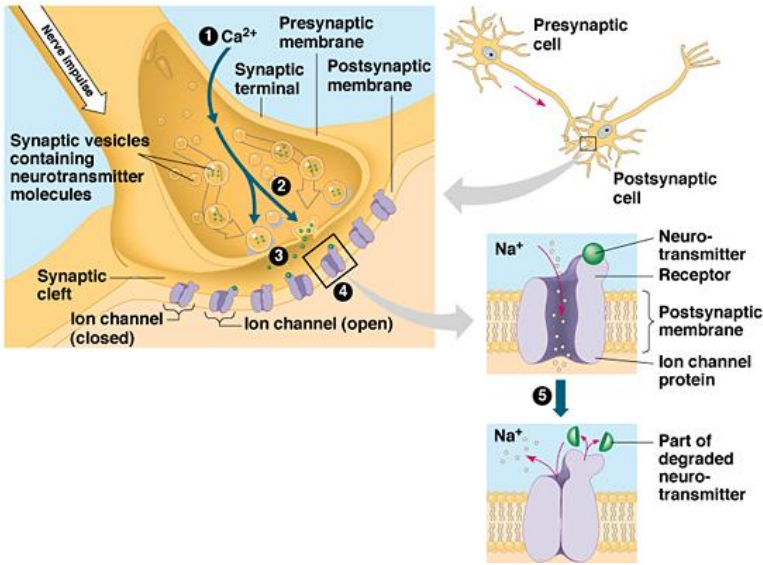
_____ Gated _____ and _____ channels are concentrated in the nodes.

_____ Action potentials "jump" from _____ to _____ during salutatory conduction.

_____ Does this **speed up** or **slow down** the rate of impulse conduction?



48.4 How An Impulse Is Transmitted From A Neuron To Another Neuron (Or To A Gland or Muscle)



_____ An impulse jumps directly from a presynaptic neuron to a postsynaptic neuron in an _____ synapse.

_____ Two cells connected by electrical synapses are connected to each other by _____.

_____ The gap between two neurons at a chemical synapse is called a _____.

_____ Neurotransmitters are contained within small sacs called _____.

_____ The gated ion channels on the postsynaptic neuron are _____ (**chemically / electrically**) gated.

_____ Ligand gated channel that is permeable to both Na^+ and K^+ and leads to depolarization

_____ A ligand gated channel that is permeable to both K^+ and Cl^- and leads to hyperpolarization

_____ What two things may happen to a neurotransmitter after its union with a receptor?

_____ Is the impulse in the post-synaptic neuron as "strong" as it was in the presynaptic neuron? (**Yes / No**)

_____ One postsynaptic neuron may receive inputs from chemical synapses with _____ of synaptic terminals.

_____ Factors that affect the magnitude of the postsynaptic potential include the _____ of neurotransmitter.

_____ A post-synaptic potential becomes _____ (**larger / smaller**) with distance from the synapse.

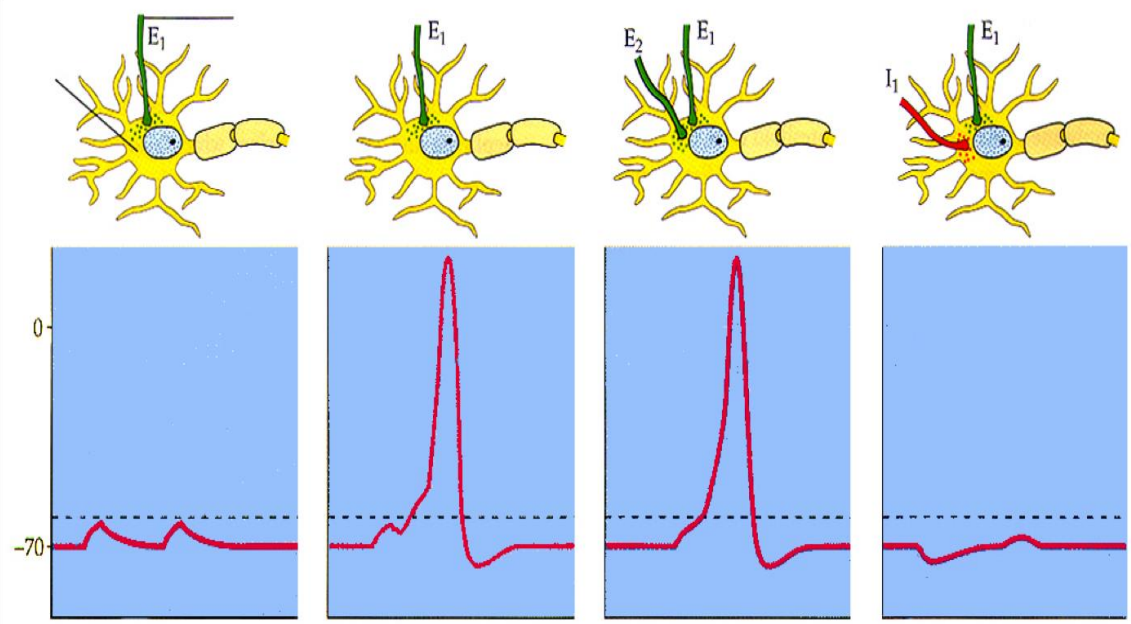
_____ A single excitatory postsynaptic potential (EPSP) usually _____ (**will / will not**) reach the threshold and trigger action potential.

_____ When two excitatory postsynaptic potentials (EPSPs) occur in rapid succession at a single synapse they _____ and are called temporal summation.

_____ When two EPSPs from different synapses stimulate the same neuron they can also add together and are known as _____ summation.

_____ The same effect can be seen with _____ but effect hyperpolarization rather than depolarization.

_____ The a _____ h _____ is the neurons integrating center.



Neurotransmitters

More than _____ (#) neurotransmitters have been identified and a single neurotransmitter may bind specifically to more than _____ (#) different receptors. They can e_____ and i_____ postsynaptic cells depending on the receptor.

Neurotransmitter Matching: Match the following neurotransmitter or class of neurotransmitters with their description.

- A. Acetylcholine
- B. Amino Acids
- C. Biogenic amines
- D. Dopamine
- E. Endorphins
- F. GABA
- G. Glutamate
- H. Nitric oxide
- I. Norepinephrine
- J. Neuropeptides
- K. Serotonin

- _____ Functions at neuromuscular junctions, memory formation and learning
- _____ Response terminated by acetylcholinesterase
- _____ Causes ion channels to open in skeletal muscle for response
- _____ Receptors in PNS can bind with nicotine causing stimulant effect
- _____ Activates a signal transduction pathway in the heart slowing the heart rate
- _____ Disrupted by the gas sarin which leads to paralysis from build up of neurotransmitter
- _____ Bacteria produce toxin that blocks release of this neurotransmitter leading to botulism

- _____ Group active in the vertebrate CNS and PNS
- _____ Key role in long term memory
- _____ Neurotransmitter at most inhibitory synapses in brain by increasing permeability to Cl⁻

- _____ Group synthesized from amino acids
- _____ Excitatory neurotransmitter in autonomic nervous system and functions as a hormone
- _____ Made from tyrosine and affects sleep, mood, attention and learning
- _____ Made from tryptophan and affects sleep, mood, attention and learning
- _____ Parkinson's is associated with a lack of this neurotransmitter
- _____ Prozac enhances the effect of this neurotransmitter

- _____ Group that is made of short chains of amino acids
- _____ Function as natural analgesics decreasing pain perception
- _____ Opiates mimic this neurotransmitter and its effects such as decreased urine output, increased euphoria
- _____ Dissolved gas that acts as a local regulator, relaxes smooth muscles