The Nervous System

- has 2 basic functions:
  1. to move/control the body
  2. to react to stimuli in the environment

- is divided into 2 divisions:
  1. Central Nervous System (C.N.S)
     (includes the brain & the spinal cord)
  2. Peripheral Nervous System (P.N.S)
     (includes all the nerves that go to & from the C.N.S)

    - the brain, spinal cord and nerves are made up of nerve cells called neurons which are specialized to carry nerve impulses:

Neurons have 3 basic parts:

- **Dendrites**: conduct nerve impulses **TOWARD** the cell body

- **Cell Body**: where the nucleus and many organelles of the neuron are
- **Axons:** conduct nerve impulses **AWAY** from the cell body

Naming dendrites and axons depends only on the direction of the nerve impulse.

**A Generalized Neuron**

- dendrites and axons are sometimes called **FIBERS**

A = nucleus  
B = dendrites  
C = cell body  
D = Schwann cells: has a nucleus and secretes the sheath/ wraps around axon many times and lay down several layers of plasma membrane
E = axon
F = Nodes of Ranvier: spaces in sheath, exposing axon
G = myelin sheath: is Schwann cell plasma membrane made of myelin (a lipid substance that is an excellent insulator) that covers most long fibers; gives nerve fibers their white glistening appearance; plays a role in nerve regeneration – if axon severed, myelin sheath remains and serves as a passageway for new fiber growth

H = effector (bulb): muscle or gland that responds to nerve impulse

**There are three types of neurons:**
1. **SENSORY (AFFERENT) NEURON**: takes a message (nerve impulse) from a sense organ (receptor) to CNS.
   - has **long** dendrite & **short** axon

2. **MOTOR (EFFERENT) NEURON**: takes message (nerve impulse) from the CNS to an effector muscle or gland
   - has **short** dendrites, **long** axon

3. **INTERNEURON (CONNECTOR)**: completely contained within CNS (they make up your brain and spinal cord)
   - they connect sensory neurons to motor neurons and convey messages within the CNS
   - have **short** dendrites and **short or long** axon
All 3 types of neurons work together:
Nerve Impulses

- Electrical current is a result of movement of charges. Nerve impulses are the result of the movement of charged ions across a neuron membrane.

- Neurons have a cell membrane with 3 important features:
  1. Na\(^+\)/K\(^+\) pumps: they work by active transport to move both Na\(^+\) (sodium) and K\(^+\) (potassium) ions
  2. Na\(^+\) gates: pores that open and close to allow Na\(^+\) to move easily across the membrane
  3. K\(^+\) gates: pores that open/close to allow K\(^+\) to move easily across the membrane

The Na\(^+\)/K\(^+\) pump (because it uses ATP for active transport) can move both of these ions against their concentration or electrical gradient.

The Na\(^+\) and K\(^+\) gates, when open, will only allow these ions to move down their concentration gradient (high to low) and down their electrical gradient (towards the more negative side)
Transmission of a Nerve Impulse Along a Neuron

- There are **three distinct phases** in the generation of a nerve impulse along an axon: the **RESTING phase**; the **ACTION phase** (consists of depolarization and repolarization), followed by a **RECOVERY phase**

### A. RESTING POTENTIAL: (Before an impulse)

At rest, the neuron has a “membrane potential” of -65mV which means that there are more negative ions inside the neuron than outside the neuron.

The Na⁺/K⁺ pumps (active transport) keep all the Na⁺ out and K⁺ in. All gates are closed.
B. UPSWING OF THE ACTION POTENTIAL (AKA DEPOLARIZATION)

- when a neuron is stimulated, a nerve impulse (action potential) will be generated
- **Na⁺ gates open** and Na⁺ moves in (down both the concentration & electrical gradients)
- membrane potential becomes +40mV. (inside of axon becomes positive)

C. DOWNSWING OF THE ACTION POTENTIAL (AKA REPOLARIZATION)

- when the membrane potential reaches +40mV, the **K⁺ gates open**
- K⁺ moves out (down both the concentration & electrical gradients.)

- membrane potential becomes -65mV again (repolarization since inside of axon becomes negative again)
D. RECOVERY (REFRACTORY) PERIOD (After an impulse, preparing for another)

The Na\(^+\)/K\(^+\) pumps work to restore the original distribution of Na\(^+\) and K\(^+\).
• The speed of nerve impulses is **quite rapid**. This is due to the structure of the nerves. Specifically, the **MYELIN SHEATH** of most nerve fibers (this sheath is formed by tightly packed spirals of the cell membrane of **Schwann cells**) and the interruptions or gaps of the sheath called the **NODES OF RANVIER**.

- The speed of transmission is ~200 m/s in myelinated fibers, but only 0.5 m/s in non-myelinated fibers.
- The reason is that the nerve impulse "**jumps**" from **node to node** in myelinated fibers. In non-myelinated fiber (Nodes of Ranvier), the nerve impulse must depolarize and repolarize each point along the nerve fiber.
**Step 1: Sodium moves in**  
Sodium channels open, Na⁺ ions diffuse into axon.

**Step 2: Depolarization**  
The inside of the axon has become positive in that region. This is called **depolarization**.

**Step 3: Na⁺ channels close, K⁺ open**  
Potassium channels open, K⁺ ions diffuse out of axon.

**Step 4: Repolarization**  
The movement of K⁺ ions counters the depolarization. The voltage difference across the membrane returns to the resting potential level (-60mV).

**Step 5: Recovery Phase**  
Na⁺ and K⁺ actively transported back across membrane until they are distributed in the same concentrations as before the impulse was sent.

**Step 6: Depolarization of adjacent part of axon**  
Sodium channels open, Na⁺ ions diffuse into axon.

The impulse will continue to move down the axon until it reaches the synapse.
Transmission of Impulses across Synapses

- **What happens to a nerve impulse once it reaches the end of an axon? How does one nerve communicate with another?**

- The answer lies in the specialized regions at the ends of axons called **SYNAPSES**.

- **Synapse**: the region between end of an axon and the cell body or dendrite to which it is attached.

- **Synaptic Endings**: swollen terminal knobs on the ends of axon terminal branches.

- **Pre-synaptic Membrane**: the membrane of the axon synaptic ending.

- **Postsynaptic Membrane**: the membrane of the next neuron just beyond the axon's synaptic membrane.

- **Synaptic Cleft**: the space between the presynaptic and the postsynaptic membranes.

- **Neurotransmitter Substances** (neurotransmitters): chemicals that transmit the nerve impulses across a synaptic cleft.
• **Synaptic Vesicles**: contain the neurotransmitters. Contained near surface of synaptic endings.

• **Acetylcholine** (Ach), **Noradrenalin** (NA), **Serotonin**, **Adrenalin** (epinephrine) are some important neurotransmitters

**Sequence of events:**

1. Nerve impulse travels along axon, reach a synaptic ending.

2. Arrival of nerve impulse at synaptic ending changes membrane ----> **Ca**++ flows into ending

3. Ca++ ions cause **contractile proteins** to pull synaptic vesicles to the inner surface of the presynaptic membrane.

4. Vesicle **fuses** with the presynaptic membrane, **releasing neurotransmitters** into the synaptic cleft by exocytosis.
5. **Neurotransmitters diffuse across synaptic cleft to receptors** on postsynaptic membrane. Each different neurotransmitter will have a specific receptor. Ca$^{++}$ is pumped back out of the bulb to prepare for the next impulse.

6. The neurotransmitter may **“excite”** the next neuron when it binds to a receptor. If so, Na$^{+}$ will diffuse in through gates and if the potential reaches +40 mV, the K$^{+}$ gates will open... causing nerve impulse to be transmitted down the dendrite of the second neuron. Neurotransmitter may **“inhibit”** the next neuron. If so, no Na$^{+}$ enters and no impulse results.

7. Once a neurotransmitter has initiated a response, enzymes on the post synaptic membrane will break it down. Ie. Acetylcholinesterase breaks down Ach. Unused neurotransmitters may be broken down or reabsorbed into the axon bulb and recycled.

- Transmission across a synapse is **one-way** because only the ends of axons have synaptic vesicles that are able to release **neurotransmitters** to affect the potential of the next neurons.

- **STIMULATION or INHIBITION** of postsynaptic membranes can occur
• a neuron is on the receiving end of many synapses - some may be giving inhibitory and some may give stimulatory impulses. Whether or not the neuron they are attached to fires depends on the **SUMMARY EFFECT** of all the excitatory neurotransmitters received

• Proper brain and nervous system function depends on the **proper balance** of excitatory and inhibitory synaptic transmitters
DRUG ACTION AND NEUROTRANSMITTERS

• There are many drugs that are used to alter the mood and/or emotional state of the user. In general, mood-altering drugs particularly affect the RAS and limbic system, and they either promote or decrease the action of a particular neurotransmitter.
There are basically 5 ways a drug can act:
1. The drug stimulates release of neurotransmitter.
2. The drug blocks release of neurotransmitter.
3. The drug combines with neurotransmitter preventing its breakdown.
4. The drug mimics neurotransmitter.
5. The drug blocks receptor so neurotransmitter can't be received.

Drugs either promote or decrease the action of neurotransmitters, either stimulating or inhibiting the action of excitatory transmitters or inhibitory transmitters. Stimulants either enhance excitatory transmitters or block the action of inhibitory transmitters. Depressants either enhance the action of an inhibitory transmitter or block the action of an excitatory transmitter.

<table>
<thead>
<tr>
<th>Drug Action</th>
<th>Type of Neurotransmitter</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocks neurotransmitter</td>
<td>Excitatory</td>
<td>Depression</td>
</tr>
<tr>
<td>Enhances neurotransmitter</td>
<td>Excitatory</td>
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</tbody>
</table>
THE PERIPHERAL NERVOUS SYSTEM: voluntary and involuntary control

• consists of all nerves outside the CNS
• nerves consist of many nerve fibers (long parts of neurons) held together by “myelin”
• consists of nerves that contain only **long dendrites** and/or **long axons**

*There are 3 types of nerves:*

1. **Sensory nerves**: a bundle of nerve fibers that consists of only **long dendrites of sensory neurons**

2. **Motor nerves**: a bundle that consists of only the **long axons of motor neurons**

3. **Mixed nerves**: a bundle that contains both the **long dendrites of sensory neurons** and the **long axons of motor neurons**

The cell bodies of the neurons are found only in the CNS or in “**ganglia**” which are collections of cell bodies in the PNS
• we have **12 pairs of cranial nerves** attached to the brain
  • some are **sensory**, some are **motor**, and others are **mixed**
  • are a part of the **PNS**
  • serve the **head**, **neck**, and **face** regions except for the **Vagus nerve**, which branches to serve internal organs

• we have **31 pairs of Spinal Nerves**
  • are **mixed nerves** leaving the spinal cord by **two short branches** (called **ROOTS**) which lie **within the vertebral column**

  • of these, the **Dorsal Root** (Y) can be identified by the presence of an **enlargement** called the **Dorsal Root Ganglion** (W), which contains the **cell bodies** of the **sensory neurons** whose dendrites conduct impulses toward the cord
- the **VENTRAL ROOT** (Z) of each spinal nerve contains axons of **motor neurons** that conduct impulses away from the cord

- the two roots *join just before the spinal nerve leaves the vertebral column*

**SOMATIC NERVOUS SYSTEM**: includes *all the nerves that serve the musculoskeletal system and the exterior sense organs* (including skin). Exterior sense organs are **RECEPTORS** (receive environmental stimuli and begin nerve impulses). Muscle fibers are **EFFECITORS** that react to the stimulus.

The Reflex Arc
• **Reflexes** are automatic, involuntary responses to changes occurring inside or outside the body. Can involve the brain (e.g. blinking) or not involve brain (e.g. withdraw hand from hot stove).

• The **Reflex arc** is the main functional unit of the nervous system. It allows us to react to internal and external stimuli.

*Path of a simple Reflex Arc:*

1. **Receptor** (e.g. in skin) - generates a nerve impulse
2. **Sensory Neuron** - takes message to CNS. Impulses move along dendrite, proceed to cell body (in dorsal
root ganglia) and then go from cell body to axon in **gray matter** of cord.

3. **Interneuron** - passes message to motor neuron

4. **Motor neuron** - takes message away from CNS to axon of spinal nerve

5. **Effector** - receives nerve impulses and **reacts**: glands secrete and muscles contract

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THE AUTONOMIC NERVOUS SYSTEM

- **is part of the PNS** - made of **motor neurons** that control the internal organs **AUTOMATICALLY** (usually **unconsciously**).
- **is divided into SYMPATHETIC and PARASYMPATHETIC** nervous systems. These two systems connect to the same organs but have **opposite effects**.
• Each system functions **unconsciously** on internal organs and utilize **two motor neurons** and **one ganglion** for each nerve impulse.

**SYMPATHETIC NERVOUS SYSTEM:**

• It is especially important during **EMERGENCY SITUATIONS** and is associated with "**FIGHT OR FLIGHT**" reaction. For example, in an emergency, it causes the following:
  • energy directed **away from** digestion
  • pupils **dilate**
  • **heart rate increases**
  • **perspiration increases**
  • **salivation decreases**
  • breathing rate increases

• the **neurotransmitter** released by the postganglionic axon of the Sympathetic nervous system is **NORADRENALIN** (which is closely related to adrenalin -- a known heart stimulant). **Noradrenalin** is released by postganglionic axon ---> heart rate accelerates
• Fibers for this system arise from **middle part (thoracic-lumbar) of the spinal cord**. Preganglionic fiber is **short**, postganglionic fiber (which contacts the organ) is **long**.

**PARASYMPATHETIC NERVOUS SYSTEM**

• The parasympathetic System promotes all the internal responses associated with a **RELAXED state (REST & DIGEST)**. For example:
  • causes the pupils to contract
  • energy diverted for digestion of food
  • heart rate slows
• Important neurotransmitter in this system is **ACETYLCHOLINE**.
• Fibers for this system arise from **upper and lower part of spinal cord** (cranial and sacral nerves).
• Preganglionic fiber is **long**, postganglionic fiber is **short** because the ganglia lie near or within the organ.

**THE CENTRAL NERVOUS SYSTEM**

• The CNS consists of the **BRAIN** and **SPINAL CORD**.
• The CNS lies in the **mid-line** of the body and is the place where **sensory information is received** and **motor control is initiated**.

• **Protected** by **BONE** (skull, vertebrae). They are also wrapped up in **three protective membranes** called
MENINGES (spinal meningitis is infection of these membranes). Spaces between meninges are filled with cerebrospinal fluid for cushioning and protection. This fluid is also found within central canal of the spinal cord and ventricle of brain.

Spinal Cord: the nervous system’s “superhighway”

- contains central canal filled with cerebrospinal fluid
- GRAY MATTER (inner layer) containing cell bodies of neurons and short fibers. Looks kind of like a butterfly with open wings.
- In the gray matter, dorsal cell bodies function primarily in receiving sensory information, and ventral cell bodies send along primarily motor information.
- WHITE MATTER (outer layer) containing long fibers of interneurons that run together in bundles called tracts that connect the cord to the brain.
- Within the white matter, ascending tracts take information to the brain; descending tracts in the ventral part carry information down from the brain.

THE BRAIN

- The brain itself contains parts which function in the coordination of movement, sensing, &
consciousness (and all that entails), as well as areas that are below the level of conscious control.

The Unconscious Brain

- **MEDULLA OBLONGATA** (X) - Lies closest to spinal cord. Controls heart rate, breathing, blood pressure, reflex reactions like coughing, sneezing, vomiting, & swallowing. An "ancient" part of brain. The Pons also participates in some of these activities, having ganglia that regulate the breathing centers in the medulla, for example.

- **THALAMUS** (V) - receives sensory information from all parts of the body and channels them to the cerebrum. It is the last portion of the brain for sensory input before the cerebrum. Serves as a **CENTRAL RELAY STATION** for sensory impulses coming up spinal cord and other parts of brain to the cerebrum.

- The thalamus has connections to various parts of the brain, and is part of the **RAS** (the **reticular activating system**), which sorts out incoming stimuli, passing on to the cerebrum only those that require **immediate**
attention. The RAS extends from the medulla oblongata to the thalamus.

- **CEREBELLUM (Z)**- controls balance and complex muscular movement. It is the second largest portion of the brain. Functions in muscle coordination and makes sure skeletal muscles work together smoothly. Responsible for maintaining normal muscle tone, posture, balance. It also receives sensory information from the inner ear (which senses balance).

- **HYPOTHALAMUS (W)** one of the most important sites for the regulation of homeostasis. It maintains internal environment, contains centers for hunger, sleep, thirst, body temperature, water balance, blood pressure. Controls PITUITARY GLAND (U) (serves as a link between the nervous system and the endocrine system).

- **CORPUS CALLOSUM (Y)**- horizontal connecting piece between the two hemispheres of the brain. Transmits information between the two cerebral hemispheres.

- The right hemisphere of the brain controls the left side of the body (except for smell), and vice versa.
• Thus, an image viewed with the right eye is actually “seen” with the left occipital lobe. The left hand is controlled by the right frontal lobe, and so on.

THE CONSCIOUS BRAIN: THE CEREBRUM

• CEREBRUM - largest, most prominent, most highly developed portion of the brain.

• Consciousness resides only in this part of the brain.

• Intellect, learning, memory, sensations are formed here.

• Outer layer is the CORTEX (gray in colour). It is the largest and most complex part of the human brain.
• Divided into right and left CEREBRAL HEMISPHERES, each consisting of four lobes: FRONTAL, PARIETAL, TEMPORAL, and OCCIPITAL lobes. There is a fifth lobe called the INSULA, it lies below the surface. Its function is poorly understood. The cerebral cortex has been “mapped” in some detail. All the lobes have association areas that receive information from other lobes and integrate it into higher, more complex levels of consciousness. Association areas are concerned with intellect, artistic, and creative abilities, learning, and memory.

1. **FRONTAL** - movement, higher intellectual processes (e.g. problem solving, concentration, planning, judging the consequences of behavior, moving your tongue and mouth to speak (left side only).

2. **PARIETAL** - sensations e.g. touch, temperature, pressure, pain. Understanding speech, using words

3. **TEMPORAL** - hearing, smelling, interpretation of experiences, memory of visual scenes, music, and complex sensory patterns.

4. **OCCIPITAL** - vision, combining visual experiences with other sensory experiences.
The Extrapyramidal and Limbic Systems: movement and Emotion

• Masses of white matter that belong to the descending tracts are called the **EXTRAPYRAMIDAL SYSTEM** (includes parts of the cerebrum, cerebellum, and pons).

• The extrapyramidal system controls **BODY MOVEMENT AND POSTURE**.

• The extrapyramidal system passes into the **basal nuclei** (masses of grey matter that lie deep within each hemisphere of the cerebrum). These basal nuclei are part of the **LIMBIC SYSTEM**, which connects portions of the **frontal lobes, temporal lobes, thalamus, and hypothalamus**.

• The limbic system is involved in **EMOTIONS, MEMORY, and LEARNING**.

• It is sometimes called the emotional brain because it seems to control emotions: **Pain, Pleasure, Rage, Affection, Fear, and Sorrow**.

• Memories can be stored all over the brain, but seem to be **concentrated in the limbic system**.

• The limbic system is also essential for **short-term and long-term memory**. An example of a short-term memory is the ability to **remember a phone number** long enough to dial it. An example of long-term memory is the ability to **recall what you did yesterday**.
THE ACTION OF DRUGS ON NERVOUS SYSTEM

- **AMPHETAMINES** - structurally similar to **noradrenalin** (NA), stimulates release of NA and **dopamine** in brain. e.g. **cocaine blocks the uptake of dopamine** so it is present in the synaptic cleft longer. As dopamine is an excitatory neurotransmitter, this causes the “rush” that cocaine users experience. Overuse can lead to hallucinations and other neurological effects (e.g. extreme addicts can lose the ability to feel pleasure).
• **METHAMPHETAMINE** (Ice) has the same stimulatory effects as cocaine, but its effects last longer.

• **MARIJUANA** (*Cannabis sativa*) leaves contain a resin rich in THC (tetrahydrocannabinol), which is marijuana’s active ingredient. It causes in many people a mild euphoria along with alterations in vision and judgment, which result in distortions of space and time. Smokers will often have a very hard time speaking coherently and concentrating. Like LSD, it is classified as a hallucinogen. It can be psychologically addicting. Marijuana may act on the neurotransmitter serotonin.

• **TRANQUILIZERS** - e.g. Valium, Ativan, barbiturates, and alcohol enhance the action of the inhibitory transmitter GABA. Dependency develops when the body begins to produce less GABA on its own. Overall, tranquilizers depress brain function, and overdoses can cause death.

• **LSD** - (lysergic acid diethylamide) - affects the action of serotonin and dopamine on RAS cells involved in vision and emotion -> produces visual and auditory hallucinations and bizarre sensory sensations. LSD can cause permanent brain damage! Never take this drug.

• **CAFFEINE** - blocks the action of adenosine, a chemical that inhibits the release of neurotransmitters. Therefore, it acts as a stimulant.
• **NICOTINE** - enhances the action of acetylcholine. One of the most **addictive** compounds known.

• **ALCOHOL** - enhances the action of the inhibitory transmitter GABA. Therefore it acts as a **depressant**. Dependency develops when the body begins to produce less GABA. Death can occur from over consumption because of its depressing effect on brain functions. Habitual use can also damage areas of the brain (especially the hippocampus, which can cause **memory impairment**) Also leads to **cirrhosis**.

<table>
<thead>
<tr>
<th># of drinks</th>
<th>Blood ROH Level</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.02-0.03%</td>
<td>Changes in behavior, coordination, and ability to think clearly</td>
</tr>
<tr>
<td>2</td>
<td>0.05%</td>
<td>Sedation or tranquilized feeling</td>
</tr>
<tr>
<td>3</td>
<td>0.08</td>
<td>Legal intoxication in B.C. (it is lower in some other provinces)</td>
</tr>
<tr>
<td>5</td>
<td>0.15-0.20%</td>
<td>Person is obviously intoxicated and may show signs of delirium</td>
</tr>
<tr>
<td>12</td>
<td>0.30-0.40%</td>
<td>Loss of consciousness</td>
</tr>
<tr>
<td>24</td>
<td>0.50%</td>
<td>Heart and respiration become so depressed that they cease to function and <strong>death</strong> occurs.</td>
</tr>
</tbody>
</table>

• **NARCOTICS** such as **HEROIN** and **MORPHINE** block the transmission of pain signals, as they bind to receptors meant for the body's natural **opioids** (endorphins and enkephalins). Opioids are believed to relieve pain by preventing the release of a neurotransmitter (lets call it “P”) that causes the sensation of pain from certain neurons in the spinal chord. Heroin addicts become physically dependent on the drug. With time, the body’s production of endorphins decreases. **Tolerance** develops so that
the user needs to take more of the drug just to prevent **withdrawal symptoms**. The euphoria originally experienced upon injection is no longer felt. Heroin withdrawal symptoms include perspiration, dilation of pupils, tremors, restlessness, cramps, goose-flesh, involuntary defecation, vomiting, and increase in blood pressure and heart rate.

### A Few Disorders of the Nervous System

- **HUNTINGTON’S CHOREA** - causes a progressive deterioration of nervous system culminating in insanity and death. Thought to be due to GABA malfunctions. A genetic disorder -- children have a 50% chance of developing Huntington's chorea if one of their parent has it. No cure yet.

- **ALZHEIMER’S DISEASE** - a severe form of senility marked by advanced memory loss. Affects 5 to 10% of people over 65. Is a disorder of the limbic system, as it affects both emotion and memory. Protein plaques build up in the brain and destroy brain cells. Ach secretion is considerably below normal in the brains of Alzheimer’s patients. Some drugs show limited success in forestalling advancement of disease in some patients. No cure yet.

- **PARKINSON’S DISEASE** - characterized by tremors of limbs (especially hands), muscular rigidity. Thought to be due to a lack of **dopamine**. Some modern medicines are symptomatically effective. No cure yet.

- **EPILEPSY** - caused by disturbances of normal communication between RAS and cerebral cortex. Causes episodes of convulsions known as seizures. There are "grand mal" and "petite mal" seizures. In a grand mal
seizure, the cerebrum becomes extremely excited, the individual may lose consciousness. The seizure only stops when the neurons become fatigued. Medicines (like Dilantin) are effective in treating and preventing seizures. There is still no cure for this disease.

- **CEREBRAL PALSY** - characterized by spastic weakness of arms and legs. Caused by lack of oxygen during birth which damages motor areas of cerebral cortex.

- **SCHIZOPHRENIA**: severe mental illness is probably linked, in part, to a **surplus** of dopamine.

- **DEPRESSION** is thought to be linked to deficiencies in the neurotransmitter serotonin and/or norepinephrine. Drugs such as imipramine and Prozac work by increase the concentrations of these substances in limbic system synapses. Depression is a serious medical disorder that affects more one person in 10 during their lifetime.