<table>
<thead>
<tr>
<th>Neurotransmitter</th>
<th>Effect</th>
<th>Clinical Examples</th>
</tr>
</thead>
</table>
| Acetylcholine (ACh)   | Excitatory or Inhibitory depending on receptors.  
                          | Always excitatory at skeletal muscle.                                                       | • Reduced levels of ACh in some brain areas are noted in Alzheimer’s patients.  
                          |                                                             | • Nicotine mimics ACh in the brain triggering the release of excitatory hormones such as epinephrine and norepinephrine.  
                          |                                                             | • Effects of ACh at skeletal muscle are prolonged by organophosphate insecticides (Malathion) and nerve gas which inhibit AChase resulting in tetanic muscle spasms and neural “frying.”  
                          |                                                             | • Release of ACh at skeletal muscle is inhibited by botulinus toxin.  
                          |                                                             | • ACh receptors at skeletal muscle can be blocked by curare.  
                          |                                                             | • Reduction in # of nicotinic of ACH receptors at skeletal muscle in myasthenia gravis.  
                          |                                                             | • ACh receptors decrease in some brain areas in Alzheimer’s disease.                           |
| Norepinephrine (NE)   | Excitatory or Inhibitory depending on receptors.  
                          | A “feel good” NT.                                                                             | • NE and Dopamine are released in greater amounts in your brain helping to create those “warm fuzzy” feelings associated with affection, romance, love, etc. Infants who receive lots of affection show more rapid and extensive brain development.  
                          |                                                             | • Cocaine and amphetamines increase the release and block the reuptake of NE and dopamine resulting in over stimulation of the cerebral cortex. This is the “rush” users get addicted to.  
                          |                                                             | • Tricyclic antidepressants (Elavil & others) inhibit reuptake of NE and serotonin from synaptic clefts thereby prolonging their effects.  
                          |                                                             | • NE is released in greater amounts in your brain when you have a positive “can do” attitude. This causes the release of more nerve growth factor to help with learning and/or recovery from stroke. People with positive attitudes recover faster and more completely.  
                          |                                                             | • NE is released in greater amounts during the “fight or flight” response thereby increasing the # of neurons responding to sensory input. You perceive this as “heightened awareness.”  
                          |                                                             | • MAO inhibitors prolong the effects of NE and serotonin by inhibiting the action of the enzyme monoamine oxidase (MAO).                                          |
| Endorphins and Enkephalins | Generally Inhibitory | • Your own natural opiates... “Your body’s own morphine.”  
                          |                                                             | • Inhibit the sensation of pain by:  
                          |                                                             | (1) inhibiting the release of substance P or  
                          |                                                             | (2) inhibiting (filtering out with IPSPs) ascending pain messages at the hypothalamus or thalamus or by enhancing the release of dopamine at frontal cortex.  
<pre><code>                      |                                                             | • Narcotic pain killers such as morphine, Demerol, heroin, and methadone mimic endorphins &amp; enkephalins. They bind to and activate the same receptor sites. |
</code></pre>
<table>
<thead>
<tr>
<th>Neurotransmitter</th>
<th>Effect</th>
<th>Clinical Examples</th>
</tr>
</thead>
</table>
| Substance P      | generally Excitatory | - The “Pain NT.”
- Released in the spinal cord at the ends of afferent (sensory) neurons carrying pain impulses to the CNS.
- Endorphins, enkephalins, morphine, heroin, etc. may reduce pain by inhibiting the release of Substance P thereby reducing the # of impulses reaching the cerebral cortex. |
| Serotonin        | Generally Inhibitory | - Involved with mood, anxiety, appetite, sleep induction, memory, and learning..
- Depending upon location in brain the effect may be calming & soothing OR stimulating and “mood elevating” similar to the “feel good” NTs.
- Chocolate elevates serotonin levels.
- Helps regulate the amount of information getting through the thalamus to the frontal cortex.
- Serotonin also helps you to be cautious and careful and use reasonable judgment. Drinking alcohol decreases serotonin levels causing you to have poor judgment, act irrationally, start fights, act stupid, think you can drive safely when you can’t, etc.
- Deficiencies of serotonin lead to anxiety and depression.
- Reuptake of serotonin is inhibited by antidepressants such as Prozac and Paxil which are Serotonin Specific Reuptake Inhibitors (SSRI). Effects of serotonin at chemical synapses are thereby prolonged.
- Levels of serotonin are often elevated in schizophrenia causing delusions, euphoria, & hallucinations. |
| Dopamine         | generally Excitatory in cerebral cortex, Inhibitory in the substantia nigra of the midbrain | - Dopamine is released (along with NE) in greater amounts causing those “warm fuzzy” feelings associated with affection, romance, love, etc.
- Endorphins cause levels of dopamine to increase thereby “smothering” the brain with pleasurable sensations rather than painful sensations.
- Cocaine and amphetamines increase the release and/or block the reuptake of dopamine and NE resulting in over stimulation of the cerebral cortex. This is the “rush” users get addicted to.
- Dopamine deficiencies are often present in cases of schizophrenia.
- Dopamine deficiencies are present in Parkinson’s disease. Treatment is L-dopa to stimulate the synthesis of dopamine. |
| Glutamate        | generally Excitatory | - The major excitatory NT in the brain
- Important in learning and memory
- The “Stroke NT.” During a stroke, oxygen deprived neurons release large amounts of glutamate causing nearby neurons to release nitric oxide (NO) which then damages or kills other nearby cells. |