Biology 3201 Nervous System #6: Effects of Drugs at Synapses

Toxins

- prevent the release of acetylcholine
  - ex. Clostridium botulinum (botulism: muscle paralysis)/ Clostridium tetani (tetanus: a disease characterized by painful muscular spasms that can lead to respiratory failure and, in up to 40% of cases, death)
- decrease the permeability of the post synaptic fibre
  - ex. Curare (common name for various arrow poisons originating from South America)
Stimulants

- speed up the CNS; increase energy and confidence; cause an excess of nt to be released or decrease inhibitory nt’s
- ex. Caffeine, cocaine, MDMD (ecstasy), nicotine, amphetamines, ritalin
- Ecstasy depletes serotonin supply, and long term use may permanently alter neurotransmitter levels in the CNS

Amphetamines and cocaine bind to — thus blocking — transporters used for the reuptake of dopamine (and noradrenaline) into postynaptic neurons. This causes the level of dopamine to rise in the synapses. High levels of dopamine in an area of the brain called the nucleus accumbens appear to mediate the pleasurable effects associated with these (as well as other) psychoactive drugs.
The chief medical uses for amphetamines and amphetamine-like drugs are

- to help people lose weight (because they suppress appetite);

- to help children with attention deficit/hyperactivity disorder (ADHD) to perform better in school
  
  (At first glance, this second use seems counterproductive. This controversial procedure seems to work by increasing the alertness of the child so that it can focus its energies more effectively on the tasks in front of it.)

Cocaine

Cocaine has been used for thousands of years by certain tribes in the Andes of South America. Cocaine and some of its derivatives have legitimate medical uses as local anesthetics (e.g., "Novocain"). However, the widespread recreational use of cocaine has created serious social problems.
Ecstasy (MDMA)

- MDMA (methyleneoxyamphetamine)
- psychoactive drug chemically similar to the stimulant methamphetamine and the hallucinogen mescaline
- club drug

Causes a sharp increase in body temperature (hyperthermia), resulting in liver, kidney, and cardiovascular system failure
- Depletes serotonin
- long term use leads to permanent changes in the brain’s neurotransmitter supply
- can lead to changes in brain function, affecting cognitive tasks and memory.
- leads to symptoms of depression several days after its use.
Depressants (sedatives)

- slow down the CNS; relaxes and causes people to feel less pain. Also decreases coordination and movement
- ex. Alcohol, heroin, morphine, Valium, anesthetics
- the drug Valium increases GABA levels to reduce anxiety
- anesthetics can be general or local
  - local: affect only a small area
  - general: affect all nervous system activity

Depressants

- Sedatives induce sleep

- prevent the release of an excitatory nts, or increase inhibitory nt’s, or decrease the permeability of the post synaptic fiber.

  - (eg alcohol, tranquilizers, barbituates)
Ethanol

- higher doses depress brain centers involved in such important functions as pain sensation, coordination, and balance.

- Enhance the inhibitory effects of GABA

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- barbiturates and ethanol both bind to a subset of GABA receptors designated $\text{GABA}_A$ receptors. These are channels that enhance the flow of chloride ions ($\text{Cl}^-$) into the postsynaptic neuron, thus increasing its resting potential and making it less likely to fire.

- By binding to the $\text{GABA}_A$ receptor, barbiturates (and ethanol) increase the natural inhibitory effect of GABA synapses.

- Because they bind to the same receptors, barbiturates and alcohol act additively. The combination producing a depression greater than either one alone.
Anti-depressants

- serotonin re-uptake inhibitors
  - Zoloft
  - Paxil
  - Prozac

Narcotics ( opiates )

- Opiates depress nerve transmission in sensory pathways of the spinal cord and brain that signal pain. This explains why opiates are such effective pain killers
  - ( eg opium, morphine, codeine, heroin, demerol, oxycontin )
- addictive, quickly producing tolerance and dependence
Anesthetics

- general decrease in CNS arousal/excitability level; used therapeutically for anesthesia
  - (eg nitrous oxide, ether)

- Most of these are volatile hydrocarbons or ethers. Diethyl ether and chloroform are seldom used today, having been replaced by safer alternatives such as isofluorane, an fluorinated ether.

- They bind to GABA receptors in the spinal cord and brain decreasing the sensitivity of the postsynaptic neurons.

- Used as an epidural during childbirth
Psychogenics

- includes two subclasses: hallucinogens and cannabinoids

1. Hallucinogens

- produce altered states of consciousness
- decreases permeability of post sf in brain
- eg LSD - Lysergic acid diethylamide
2. Cannabinoids

- marijuana, hashish
- active ingredient - THC (Tetrahydrocannabinol)
- produces
  - the drowsiness of sedatives like alcohol
  - the dulling of pain (like opiates)
  - in high doses, the perception-distorting effects of the psychedelics

- increasingly used for their anti-nausea and appetite-stimulating effects in severely ill patients (e.g., AIDS)

- Unlike sedatives and opiates, however, tolerance to THC does not occur
Addiction

- a state in which an organism engages in a compulsive behavior, even when faced with negative consequences.
- characterized by loss of control in limiting intake of the addictive substance.

Tolerance

- occurs when the person no longer responds to the drug in the way that person initially responded.
- it takes a higher dose of the drug to achieve the same level of response achieved initially.