Psychoactive Drugs & The Brain
Psychoactive Substances & The Brain

1. Psychoactive substances enter the bloodstream via oral administration, inhalation, smoking, or injection.

2. Psychoactive substances must somehow move from the blood to the brain in order for central nervous system effects to occur.
Blood-Brain Barrier

- Barrier represented by tightly-packed cells in blood vessel
- Prevents many substances crossing between blood & brain (CLD)
- Is protective, to keep foreign materials away

Illustration: Carol Donner, Tucson, AZ
Blood-Brain Barrier

The Blood Brain Barrier

- Pore passage
- Lipid-soluble substances
- Water-lined pore
- Transport mechanisms
- Carrier-mediated transport
- Astrocyte processes
- Tight junction (no pores)
- Lipid-soluble substances

Most capillaries in body
Brain capillaries
Capillaries in cross section
Blood-Brain Barrier

• How do materials get through?
  – Very small molecules can get between cells
  – Fat-soluble substances are more likely to get through cell membranes
  – Chemical substances can also move across barrier if they have carriers
  – Some substances cross with help of receptors
  – Some areas of blood-brain barrier are weaker than others
  – Image (Nature.com)
  – Pramod Dash, UT Medical School (fig. 11.2)
The Brain’s Reward Pathway

- Parts of brain responsible for certain tasks
- Reward pathways are activated when a person receives stimulus to induce pleasure
  - Ventral tegmental area, nucleus accumbens, prefrontal cortex

Brain Cells

- Neurons
  - Received most research attention
  - Focus of HEA150

- Glial cells
  - Receiving more research attention
  - Appear to have important supportive roles
Nervous System: Neuron

- Basic unit = neuron
- Dendrites receive electrical information
- Soma/cell body processes electrical information
- Axon sends electrical information down neuron
- End of axon is terminal, which can translate electrical message into chemical message
Communication Between Neurons

- Neurons do not physically connect
- Communication occurs in space between neurons: the synapse
- When electrical impulse travels down axon of one neuron, a chemical is released, a neurotransmitter

Image source: Neurevolution.net: Chronicling the Cognitive Revolution in Neuroscience
Communication Between Neurons

- Neurotransmitter binds to specific receptors in target neuron, like “lock and key”
- The “capture” of neurotransmitter continues electrical communication
  - Neurotransmitter may excite target neuron
  - Neurotransmitter may inhibit target neuron

Source: NIDA
Communication Between Neurons

- After the neurotransmitter connects to receptor, most is removed and returned: reuptake
- How Transmission Works (NIDA)
Communication is Complicated

- Excitation or inhibition of target (postsynaptic) neuron
- Dozens of neurotransmitters
  - Dopamine
  - Serotonin
  - GABA
- Many receptors, specific to neurotransmitters
- Neighboring neurons can also affect neurotransmission
Effects of Psychoactive Substances on Neural Communication

- Psychoactive substances can cause a release or increased release of neurotransmitter from a neuron (agonists)

Source: BCSworthpublishers.com
Effects of Psychoactive Substances on Neural Communication

- Psychoactive substances can prevent a neuron from releasing, or reduce the release of, neurotransmitter (antagonist).
Effects of Psychoactive Substances on Neural Communication

- Psychoactive substances can mimic neurotransmitters, binding to their receptors (agonists)
- Psychoactive substances can block neurotransmitter receptors, altering normal brain function (antagonist)
- Psychoactive substances can block the reuptake of neurotransmitters, making effects of neurotransmitters linger (agonist)
- Agonist and antagonist examples (apehrlichman.com)
Effects of Psychoactive Substances on Neural Communication: Blocking Reuptake of Neurotransmitter
Communication Between Neurons

- Animation – normal, psychoactive substances (President & Fellows of Harvard College)
- Animation cocaine (NIDA)
- Animation, methamphetamine (MedXclusive Learning, via YouTube)
- Animation, amphetamines (The Brain from Top to Bottom)
- Animation, Psychoactive Drugs and the Brain (Biology of Humans, Pearson Education)
- Animation, Selective Serotonin Reuptake Inhibitors (NeuroscientificallyChallenged)
Mouse Party (University of Utah)

- Ecstasy
- LSD
- Marijuana
- Heroin
- Alcohol
- Cocaine
- Methamphetamine