HOW PSYCHOACTIVE DRUGS AFFECT PEOPLE

This chapter examines how drugs reach the brain and the ways in which they affect brain chemistry. Drugs can be inhaled, injected, swallowed or absorbed through mucous membranes or through the skin. Once a drug is introduced to the body it travels through the circulatory system until it reaches the brain where it has the greatest effect. Drugs are principally metabolized by the liver and then excreted from the body in urine, exhaled breath, or sweat.

The body’s nervous system consists of the peripheral nervous system (autonomic and somatic) and the central nervous system (the brain and spinal cord). Using evolutionary terminology, psychoactive drugs affect both the old (primitive, survival) brain and the new (common sense, thinking) brain. The key circuit of the brain that drugs affect is the reward/control pathway, especially the nucleus accumbens septi, which serves as the brain’s “go switch” and the amygdala.

Drugs cause their effects by mimicking or modifying neurotransmitters (e.g., dopamine, serotonin, norepinephrine, endorphins, GABA). Problems occur when the stop switch located in the orbital frontal cortex of the brain’s control circuit that normally shuts off the craving becomes dysfunctional. Drugs affect the nervous system at the cellular level, particularly the synaptic gap where they are mistaken for or disrupt natural brain chemistry. An individual’s drug tolerance, tissue dependence, withdrawal, and metabolism determine additional effects. New research indicates there are “stay-stopped” switches in the brain which compromise abstinence and lead to slips and relapse.

FROM EXPERIMENTATION TO ADDICTION

In addition to the desired effects of drugs, such as getting high, self-medicating, creating energy, relieving pain, zoning out, or altering consciousness, undesirable side effects occur, some of them minor, some major, and some fatal.

The level of drug use - abstinence, experimentation, social/recreational use, habituation, abuse, and addiction - depends on the amount, frequency, and duration of use as well as a person’s susceptibility to addiction as determined by heredity and environment. The continued use of a psychoactive drug also affects a person’s vulnerability to develop addiction. All these factors cause alterations in brain chemistry known as allostasis that can affect a person for a few hours, a few days, or even a lifetime. Many of these alterations can be seen with the assistance of new imaging techniques such as SPECT, CAT, MRI, fMRI, DTI, and PET brain scans. Compulsive behaviors, such as gambling and compulsive eating, also affect brain chemistry.

Compulsion curves that illustrate the contributions of heredity, environment, and the use of psychoactive drugs or the practice of compulsive behaviors to addiction are useful when trying to design methods of treatment that will lead to recovery.
Chapter 2 - HEREDITY, ENVIRONMENT & PSYCHOACTIVE DRUGS

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Extended Outline

HOW PSYCHOACTIVE DRUGS AFFECT PEOPLE

I. INTRODUCTION (P. 2.3)

Almost 80 years ago, Doctor William Silkworth wrote in the Alcoholics Anonymous Big Book that alcoholism [and addiction] is a combination of an obsession of the mind combined with an allergy of the body. Modern imaging techniques, genetic research, neurochemical insights along with social, psychological, and physiological research continue to affirm his insights.

II. HOW DRUGS GET TO THE BRAIN (PP. 2.4–2.9)

Psychoactive drugs directly affect the central nervous system (the brain and the spinal cord). Factors that determine their effects and abuse potential (pharmacokinetics) include:

- route of administration,
- speed of transit to the brain,
- affinity for nerve cells and neurotransmitters.

The more rapidly a psychoactive drug reaches its target in the central nervous system, the greater its reinforcing effect.

A. ROUTES OF ADMINISTRATION & DRUG ABSORPTION (pp. 2.4–2.7)

The five most common ways drugs are introduced to the body are:

1. Inhaling

Smoking a drug like marijuana or inhaling a substance like nitrous oxide delivers the vaporized drug to the lungs where it is rapidly absorbed through capillaries lining the air sacs (alveoli) of the bronchi (air passages). Inhaling acts more quickly than any other method of use (7 to 10 seconds before the drug reaches the brain).

2. Injecting

Substances, such as heroin and cocaine, can be injected by three methods:

- intravenous (IV, or “slamming”)—directly into the bloodstream by way of a vein (15-30 seconds to the brain)
- intramuscular (IM, or “muscling”)—into a muscle mass 3 to 5 minutes)
- subcutaneous (“skin popping”)—under the skin (3 to 5 minutes).

Shooting up is most likely to produce an intense rush. Injecting is the most dangerous method of use because it bypasses most of the body’s natural defenses against infections such as hepatitis C or AIDS.
3. Mucous Membrane Absorption
Powdered drugs can be snorted into the nose (insufflation) and then absorbed by the capillaries. Mucous membranes can also absorb drugs - under the tongue (sublingually) or between the gums and cheek (buccally) effects begin in 3 to 5 minutes. Morphine suppositories take 10 to 15 minutes for effects to begin.

4. Oral Ingestion
An ingested drug passes through the esophagus and the stomach to the small intestine, where it is absorbed into the capillaries which carry it to the liver to be partly metabolized before being pumped back to the heart and subsequently to the rest of the body. The effects of drugs taken by mouth are delayed 20 to 30 minutes.

5. Contact Absorption
Drugs can be applied to the skin through saturated adhesive patches (e.g., nicotine, fentanyl) that allow the drug to be passively absorbed for up to seven days. It can take one or two days for therapeutic effects to begin.

B. DRUG DISTRIBUTION (pp. 2.6–2.7)
A drug is distributed by the bloodstream to the rest of the body. The bioavailability is the degree to which a drug becomes available to the target tissue. There, it will cause a direct effect, be ignored, be stored or be biotransformed. Within 10 to 15 seconds after entering the bloodstream, the drug reaches the blood-brain, blood-cerebral spinal fluid barriers, and the placental barrier.

1. The Blood-Brain, Blood-Cerebral Spinal Fluid & Placental Barriers
Psychoactive drugs infiltrate the blood-brain barrier (a series of tightly-packed cells that protect the brain) and because the brain is essentially fatty, it readily absorbs fat-soluble substances (most psychoactive drugs are fat-soluble).

The blood-cerebral spinal fluid barrier prevents unwanted substances from entering the subarachnoid space, ventricles, and spinal cord. There is also a placental barrier that provides some protection to a developing fetus.

C. METABOLISM & EXCRETION (pp. 2.7–2.9)
Metabolism is the body’s mechanism for processing, using, and inactivating a foreign substance. The liver is the key metabolic organ because it is able to break down drugs.

Excretion is the body’s mechanism for eliminating foreign substances and their metabolites. The kidneys, the key excretory organ, filter the metabolites, water, and other waste from the blood.
Some drugs, such as Valium®, are “prodrugs”, these are transformed by the liver’s enzymes into three or four metabolites that are themselves active.

A drug’s half-life is the measure of time it takes a drug to be inactivated or eliminated by the body. The half-life can be extended by polydrug use, e.g., alcohol and cocaine.

A number of factors affect the metabolism (and the half-life) of drugs: age, race, heredity, gender, health, emotional state, allergy to the drug, and the presence of other drugs.

III. THE NERVOUS SYSTEM (PP. 2.9–2.25)

The central nervous system or CNS (brain and spinal cord) consists of 100 billion nerve cells and 100 trillion connections. The CNS is half of the complete nervous system.

The peripheral nervous system or PNS (the autonomic and somatic subsystems) is the other half. It connects the CNS with its internal and external environments.

A. PERIPHERAL NERVOUS SYSTEM (PP. 2.9–2.10)

The autonomic part controls involuntary internal functions such as circulation, digestion, and respiration. It consists of the sympathetic, parasympathetic, and enteric divisions.

The somatic part transmits sensory information and then transmits any instructions from the CNS back to skeletal muscles.

B. CENTRAL NERVOUS SYSTEM (PP. 2.10)

The central nervous system analyzes messages from the peripheral nervous system, and then sends responses. The CNS also facilitates reason and the ability to make judgments about the environment. Psychoactive drugs can alter this information.

C. OLD BRAIN–NEW BRAIN & MEMORY (PP. 2.10–2.14)

Looking at the brain from an evolutionary perspective sense, the physiological changes can be interpreted as survival adaptations. The evolutionary concept also theorizes that psychoactive drugs have an affinity for natural survival mechanisms and initially cause desirable effects. The net result is that psychoactive drugs hijack and subvert the brain’s survival mechanisms.

The two major parts of the brain are defined as the old brain and the new brain.

1. Old Brain

The old brain consists of the brainstem, cerebellum, and mesocortex or midbrain which contains the limbic system (the emotional center). The spinal cord is considered part of this old-brain system. The old brain regulates physiological functions, experiences basic emotions and
cravings, and imprints survival memories. It is the old brain that orchestrates euphoric recall that become addiction memories.

2. New Brain
The new brain, also called the neocortex (cerebrum and cerebral cortex), processes information from the senses and other parts of the brain. The new brain allows humans to speak, reason, create, and remember. Because the craving to use a psychoactive drug almost always resides in the old brain, the desire for the pleasure, pain relief, and excitement that drugs promise can be very powerful, overriding the new brain’s rational arguments.

D. MEMORY (2.11–2.14)
The old and new brains carry out functions by creating, storing, and utilizing memories. Memories are the heart of an obsession to use drugs. The other element of addiction, the allergy or extra sensitivity to a drug, is reflected in neurochemical and anatomical changes to the brain. Memories are stored in dendritic spines which are formed on the dendrites of nerve cells. It takes a thousand or more memory spines to make one memory. Most of them last a lifetime. Emotionally-charged or drug-charged memories are more deeply ingrained and influential, they lead to euphoric recall which is a remembrance of positive experiences with drugs which can trigger craving and relapse.

E. THE REWARD/CONTROL PATHWAY (pp. 2.14–2.17)
The reward/control pathway encourages a human to repeat a survival action, it has two parts: a “go” switch (also called a more switch) and a “stop” switch.
The “go” part of this circuit communicates the following:
- the action is necessary for survival,
- remember how the action was achieved.
- continue the action again, and again.
The “stop,” or satiation, part of this circuit, signals when the craving has been satisfied and shuts down the “continue the action” message.

2. Hijacking the Reward/Control Pathway
When a psychoactive drug activates this circuit, the “go” or “more” switch becomes overactive and the “stop” switch becomes dysfunctional. The user gets no instruction to stop so the need to continue use gains intensity. The “do it again” (continue the action) message becomes so powerful that it causes drug-seeking behavior and addiction. The greater responsiveness to psychoactive drugs diminishes the responsiveness to normal everyday activities so the user becomes more dependent on the drug or behavior for any kind of satisfaction and pleasure.
Recovery requires reintegrating the functions of the old brain and new brain so one doesn't overwhelm the other.

1. Nucleus Accumbens (Septi)
The NAc was discovered by Dr. Robert Olds and Dr. Robert Heath in the 1950s and serves as a powerful motivator (reinforcer) for normal survival activities. When psychoactive drugs are used, the NAc becomes stimulated, hijacking its functions. The longer someone uses, the stronger the do-it-again message becomes.
The brain reacts in a certain way, not because of a bad environment, but because of the way the brain is designed. The effect of the alteration in the brain chemistry has to do with the reaction to the drug itself as well as the anticipation of using. This phenomenon may be the manifestation of an allergy which differentiates these people, and sets them apart.

2. “Stop” (Satiation) Switch
The stop/satiation circuit is crucial to keeping craving and satiation in balance. Alcohol and other drugs have the ability to turn genes on or off which changes the network of cells. The increase in neural alterations results in heightened sensitivity to a drug which increases the risk of relapse even after use stops.
There are a number of theories on ways psychoactive drugs disrupt the on/off switches of the reward/control pathway and the satiation circuits of the brain:
- there is no satiation point,
- the on/off switches are ignored or overridden
- psychoactive substances disrupt communication between the two brains
- the fasciculus retroflexus which communicates from the new brain to the old brain is damaged preventing stop messages from reaching the old brain.

The disruption of the on/off switches due to a behavioral addiction is identical to that of drug addiction.
The longer a drug is used or a behavior practiced, the more the brain changes and the harder it becomes to restore a healthy balance (homeostasis).

E. MORALITY & THE REWARD/CONTROL PATHWAY (pp. 2.17–2.18)
Throughout human history our primal urges, desires, and intense emotional memories that mostly reside in the old brain, have been pitted against reason, common sense, and morality that mostly resides in the new brain. In many addicts this conflict is more pronounced, but “the old brain rules!”
Because the "go" circuit of the reward/control pathway reacts more quickly and intensely than the neocortex, it takes a powerful, conscious effort to override cravings and desires generated by the old brain. Christian, Buddhist, Islamic, and almost all theologies teach that one must resist most primal cravings (including psychoactive drugs) to live a moral or fulfilling life.

**IV. NEUROANATOMY (PP. 2.18–2.35)**

**A. NERVE CELLS & SYNAPSES (PP. 2.18–2.19)**

When one of the five senses is activated, a signal is sent through a network of nerve cells first to the old brain for an instant reaction and then to the thalamus where it is forwarded to the new brain for a more complete reaction. Nerve impulses might fire up to 1,000 pulses per second.

Each nerve cell has four essential parts: dendrites, which receive signals, the cell body, which nourishes the cell, the axon, which carries the message to the terminals, and terminals, which relay the message to the next cell.

A synaptic gap exists between the terminals of each nerve cell preventing them from touching each other. When an electrical message arrives at the synaptic gap it releases neurotransmitters which trigger another electrical signal in the adjoining nerve cell. This electrical-chemical-electrical-chemical transmission continues until the message reaches the appropriate section of the brain or body.

**B. NEUROTRANSMITTERS & RECEPTORS (pp. 2.19–2.24)**

The discovery in the mid-1970s of endorphins and enkephalins provided an understanding of how psychoactive drugs work in the brain and the body. These neurotransmitters are called endogenous opioids, meaning “originating within the body.” Morphine, heroin, and opioids originate outside the organism.

Over the next 30 years researchers identified and associated dozens of psychoactive drugs with the neurotransmitters they affect.

Sensations or feelings that can’t be triggered by a natural neurotransmitter in the body cannot be created by a psychoactive drug. Humans can naturally create virtually all of the sensations and feelings they seek by using drugs. Some examples are:

- a terrifying experience forces the release of adrenaline that mimics part of a cocaine rush.
- sleep or sensory deprivation can produce true hallucinations through the same neurotransmitters and mechanisms affected by peyote.

Natural sensations have no side effects, drug-induced sensations do.

**Drug/Neurotransmitter Relationships**

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<tr>
<th>Drug</th>
<th>Neurotransmitters Directly Affected</th>
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Some people are drawn to certain drugs because they have a neurochemical imbalance and use the drug to self-medicate.

1. Major Neurotransmitters

Acetylcholine, the first neurotransmitter discovered, is most active at nerve/muscle junctions.

Norepinephrine (NE) and epinephrine (E) function as stimulants. Epinephrine has a greater effect on energy, norepinephrine on confidence and feelings of well-being.

Dopamine (DA) is the most crucial neurotransmitter involved in drug use and abuse. It is often called the “reward chemical.”

Serotonin helps control mood stability, e.g., depression, anxiety, appetite, and sleep.

Enkephalins, endorphins, and dynorphins are involved in pain, stress control, and euphoria.

GABA, an amino acid, is the brain’s main inhibitory neurotransmitter.

Substance P conveys pain impulses.

Anandamide is responsible for the integration of emotional sensory experiences as well as those controlling learning, motor coordination, and memory. It is mimicked by THC in marijuana.

At least 100 more neurotransmitters have been discovered.

2. Receptors for Neurotransmitters

A receptor is designed to receive a compatible neurotransmitter. Each nerve cell produces and sends only one type of neurotransmitter; but a single nerve cell can have receptors for several different types of neurotransmitters.

3. Advanced Neurochemistry

Excitatory neurotransmitters increase cell firings while inhibitory neurotransmitters reduce cell firings. Many mechanisms are involved in this transmission process, e.g., first messenger system and second messenger system.

Up regulation and down regulation (where excessive drug use will lower the number of available receptors causing a dampening of message transmission) is a crucial mechanism in creating addiction.

Other mechanisms that help regulate neurotransmitters are active transport pumps, autoreceptors, and reuptake ports.
4. Agonist & Antagonist

Drugs that mimic or facilitate the effects of neurotransmitters are called *agonists*; drugs that block neurotransmitters are called *antagonists*; drugs that partly mimic the effects of neurotransmitters are called *partial agonists*; Drugs that stabilize the receptor in its inactive state (so that it cannot react) are called *inverse agonists*.

Psychoactive drugs can:
- block the release or force the release of neurotransmitters, or prevent them from being reabsorbed;
- inhibit enzymes that help synthesize or metabolize neurotransmitters
- interfere with the storage of neurotransmitters.

Example: cocaine forces the release of norepinephrine and dopamine, heroin inhibits the release of substance P, the pain neurotransmitter. LSD alters the user’s perception of messages received from the external environment.

C. SYNAPTIC PLASTICITY. EPIGENITICS, & ALLOSTASIS

(pp. 2.24−2.25)

Synaptic plasticity is the ability of the synapse to change in strength and function when a synaptic pathway is overused or underused, often due to constant stress or the use of psychoactive drugs. Changes can last for weeks, months, or years.

Epigenetics is the field of research that studies changes in genes, also called gene expressions.

Allostasis is the overall process of achieving and maintaining functionality and balance by physiological and behavioral change through synaptic plasticity, altered neurotransmitters, and other physiological processes.

V. PHYSIOLOGICAL RESPONSES TO DRUGS (PP. 2.25−2.30)

A. TOLERANCE (pp. 225−227)

As drug use continues over a long period, the body changes to adapt to the toxin, developing a tolerance to the substance. The user must take larger and larger amounts of a drug to achieve the same effect. The body's hedonic set point (an individual's preferred level of effects from a drug) rises.

1. Kinds of Tolerance
   - **Dispositional Tolerance.** The body speeds up the breakdown (metabolism) of the drug to eliminate it.
   - **Pharmacodynamic Tolerance.** Nerve cells become less sensitive to the effects of the drug.
   - **Behavioral Tolerance.** The brain learns to compensate for the effects of the drug by using those parts of the brain not affected.
**Reverse Tolerance.** The user becomes more sensitive and therefore less able to handle even moderate amounts.

**Acute Tolerance (tachyphylaxis).** The brain and the body begin to adapt almost instantly to the toxic effects of the drug.

**Select Tolerance.** The body develops tolerance to mental and physical effects at different rates.

**Inverse Tolerance (kindling).** The body becomes more sensitive to the effects of the drug as the brain chemistry changes.

**Cross-Tolerance.** Once a person develops tolerance to one drug, a tolerance to similar drugs occurs.

**B. TISSUE DEPENDENCE (p. 2.27)**
Tissue dependence is the biological adaptation of the body due to prolonged use of drugs. Tissues and the organs come to depend on the drug to stay functional.

**Cross-Dependence.** Once tissue dependence to a specific drug occurs, the body will develop a dependence on similar drugs.

**C. PSYCHOLOGICAL DEPENDENCE (p. 2.27)**
Psychological dependence has been recognized as an important factor in the development of addictive behavior. Drugs cause an altered state of consciousness and distort perceptions pleasurable to the user.

Drugs also have the innate ability to guide and virtually hypnotize the user into continual use (called the “positive reward-reinforcing action of drugs”).

Addictive drug taking is further reinforced via drug automatism, negative reinforcement, and social reinforcement.

**D. WITHDRAWAL (pp. 2.27–2.29)**
Withdrawal is defined as the “body’s attempt to rebalance itself after cessation of prolonged use of a psychoactive drug.” Many compulsive users continue use due to the fear of withdrawal.

1. **Kinds of Withdrawal**

   **Nonpurposive withdrawal** consists of objective physical signs that are a direct result of the tissue dependence and are directly observable upon cessation of drug use by an addict.

   **Purposive Withdrawal** results either from addict manipulation or from a psychic conversion reaction (an emotional expectation of physical effects that have no biological explanation).

   **Protracted Withdrawal (environmental triggers & cues)** is a flashback or recurrence of withdrawal symptoms and a triggering of heavy craving for the drug long after an addict has been detoxified.

   **Post-Acute Withdrawal Symptoms (PAWS)** is the persistence of subtle, yet significant, emotional and physical problems that can last
for three to six months into recovery, e.g., cognitive impairment, memory problems, and emotional over-reaction.

E. THE STAY-STOPPED CIRCUIT & RELAPSE (2.29–2.30)
In 2005, scientists discovered decreased activity in five discrete areas of the brain's neocortex that correlated to a high risk of relapse in meth addicts who graduated from a 28-day residential program. More research is necessary before these findings can be used to determine if an addict will relapse and how to design a program tailored to their susceptibility to relapse.

FROM EXPERIMENTATION TO ADDICTION
People take psychoactive drugs for the mental, emotional, and physical effects they induce. Most often it is the memory of what that drug did in specific emotional situations that prompts continued use.

IV. DESIRED EFFECTS VS. SIDE EFFECTS (PP. 2.30–2.31)

A. DESIRED EFFECTS (pp. 2.30–2.31)
People use drugs to get high, for curiosity, self-medication, confidence, energy, psychological pain relief, anxiety control, peer pressure, disinhibition, boredom, altered consciousness, to deal with life problems, oblivion, and to gain a competitive edge.

B. SIDE EFFECTS (p. 2.31)
Drugs also trigger mild, moderate, dangerous, and sometimes fatal side effects. This conflict between the emotional/physical effects that users seek and the consequences of dangerous side effects is the dilemma presented by the use of psychoactive drugs. In addition to the physical and psychological side effects of drug use, social side effects, including legal, relationship, financial, and career consequences can be equally damaging.

C. POLYDRUG ABUSE (pp. 2.31–2.32)
If an addict can’t get the desired effect from one drug, they will try almost any other substance, behavior, or combination of both to attain the change of mood and physical condition they seek. Some patterns of polydrug use include

• replacement; using another drug when the desired drug is not available;
• multiple drug use; taking several drugs to attain different feelings.

Other patterns include cycling, stacking, mixing, sequentialing, and morphing (using one drug to counteract the unwanted effects of another).
VII. LEVELS OF USE (PP. 2.32–2.35)

It is necessary to know the amount, frequency, and duration of psychoactive drug use in order to judge the impact the drug use has on the individual’s life and determine treatment needs.

A. ABSTINENCE (p. 2.32)

Abstinence is abstaining from the intentional use of any psychoactive substance.

B. EXPERIMENTATION (p. 2.33)

Experimentation occurs when a person’s curiosity about the effects of a drug prompts them to try it if/when it becomes available. No pattern of use develops, and there are limited negative consequences unless large amounts are used at one time, the person has an allergic reaction, the person has a pre-existing physical or mental condition, she is pregnant, etc.

C. SOCIAL/RECREATIONAL USE (p. 2.33)

A person seeks out a known drug and wants to experience a known effect, but there is no established pattern.

D. HABITUATION (p. 2.33)

There is a definite pattern of use (the person regularly uses a particular drug) but use does not affect his or her life in negative ways.

E. ABUSE (p. 2.33)

This pattern is marked by the continued use of a drug despite negative consequences, e.g., poor social life, chaotic finances, poor legal status, ill health, lost job, poor grades, or emotional confusion.

F. ADDICTION (pp. 2.33–2.34)

Addiction comprises the four Cs, the cornerstones of addictive behavior: loss of control, compulsive drug use, powerful cravings for drugs, continued use despite increasing negative consequences associated with use.

G. CLASSIFICATION (pp. 2.34)

1. DSM-IV-TR, DSM-V & ICD

The American Psychiatric Association’s (APA’s) Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) defines drug related illnesses as:

Substance-related disorders are divided into two general categories: substance use disorders and substance-induced disorders.

Substance use disorders involve patterns of drug use and are divided into substance dependence and substance abuse.
**Substance dependence** is a pattern of repeated self-administration that can result in tolerance, withdrawal, and compulsive drug-taking behavior.

**Substance abuse** is “a maladaptive pattern of substance use leading to clinically significant impairment or distress;” i.e., continued use despite adverse consequences.

**Substance-induced disorders** include conditions that are caused by use of specific substances, e.g., intoxication, withdrawal, certain mental disorders,

2. The World Health Organization (WHO) International Classification of Diseases classifies addictions under *Mental and Behavioural Disorders*.

**VIII. THEORIES OF ADDICTION (PP. 2.35–2.36)**

Historically addiction was often perceived as a moral failure. Today, addiction is viewed through the lens of the addictive disease model, the behavioral/environmental model, the academic model, and the diathesis-stress theory.

A. **ADDICTIVE DISEASE MODEL** (p. 2.35)

This medical model, maintains that the disease of addiction is a chronic, progressive, relapsing, incurable, and potentially fatal condition that is primarily a consequence of genetic irregularities in brain chemistry and anatomy, which may be activated by the particular drugs.

B. **BEHAVIORAL/ENVIRONMENTAL MODEL** (pp. 2.35–2.36)

This theory emphasizes the overriding significance of environmental and developmental influences in leading a user to addictive behavior. Animal and human studies show that environmental factors can change brain chemistry as surely as drug use or heredity.

C. **ACADEMIC MODEL** (p. 2.36)

In this model, addiction occurs when the body adapts to the toxic effects of drugs at the biochemical and cellular levels, marked by the development of tolerance, tissue dependence, withdrawal symptoms, and psychological dependence.

D. **DIATHESIS-STRESS THEORY OF ADDICTION** (p. 2.36)

A diathesis (predisposition to addiction), is the result of genetic and environmental influences, such as stress. When a person becomes stressed or challenged by the use of psychoactive drugs or the practice of certain behaviors, neurochemistry and brain function are changed to a point where return to normal use or normal behavior is extremely difficult.

**IX. HEREDITY, ENVIRONMENT, PSYCHOACTIVE DRUGS & COMPULSIVE BEHAVIORS (PP. 2.36–2.41)**

The reasons for drug addiction are a combination of heredity, environment, and the use of psychoactive drugs

A. **HEREDITY** (pp. 2.36–2.38)

Many physical traits as well as many behaviors seem to have a heritable component. There are many genes that affect addiction; more than 100
have been associated with drug abuse. The more addiction-related genes the person has, the more susceptible they are to drug abuse and addiction.

1. Twin & Retrospective Studies
Identical twins raised in different environments have been studied to see if addiction still occurs.
Fraternal twins are compared to identical twins raised in similar environments to study the influence of environment.
The influence of parents are studied by reviewing the biological family records of alcoholics

2. Addiction-Associated Genes
A number of specific genes associated with addiction have been identified. One of the first was the DRD$_2$ A$_1$ allele gene, found in more than 70% of severe alcoholics. Although the gene only indicates a shortage of dopamine (D$_2$) receptors, it also indicates a tendency towards alcoholism, drug addiction, and compulsive behaviors.
In practical terms, people with one or more marker genes are more susceptible to developing addiction once they begin drinking or using. Conversely, genes can also help prevent dependence from developing.
There are a number of other genes implicated in dependency or resistance to dependency. P300 ERP (event-related potential) wave relates to a person's cognition, decision-making, and processing of short-term memory signals a propensity to alcohol addiction.

B. ENVIRONMENT (pp. 2.38–2.39)
Sexual/physical/emotional abuse, stress, love, nutrition, living conditions, and family relationships, all determine how a person uses psychoactive drugs.

1. Environment, Brain Development & Memory Networks
Environment helps mold the brain's architecture and neurochemistry, thus altering the way the brain reacts to outside influences. It takes at least 20 years for the brain to become “hardwired.”
Our brains remember emotionally charged events, e.g., abuse, accidents, or wartime trauma. Some youngsters begin using drugs, gambling or overeating —anything to temper pain or discomfort from their environment. The brain remembers the counter-behavior just as it remembers the stress and the pain.
Other environmental influences include stress in the home, peer pressure to drink or use, lack of practice, malnutrition, and persuasive alcohol and tobacco marketing.

C. PSYCHOACTIVE DRUGS (pp. 2.39–2.40)
Excessive, frequent, or prolonged use of alcohol or other drugs inevitably modifies many of the same nerve cells and neurochemistry that are affected by heredity and environment.
The development of tolerance, tissue dependence, withdrawal, and psychological dependence are signs that the drugs are causing physical and chemical changes in the body, creating a motivation to increase use. Finally, animal studies confirm that some drugs have greater power to compel continued use than other drugs (positive reinforcement). Psychoactive drugs cause both temporary and permanent changes in various parts of the brain that can be imaged by new techniques including a SPECT, PET, CAT, MRI, fMRI, & DTI scans. These changes are due to synaptic plasticity and the brain's need to achieve allostasis, a new balance.

D. COMPULSIVE BEHAVIORS (p. 2.41)

Certain behaviors, such as eating, shopping, gambling, engaging in sexual activity, playing video games, and Internet use can become compulsive in ways that mimics compulsive drug use. Compulsive behaviors are recognized as actual dysfunctions of brain chemistry. Compulsive behaviors are different from obsessive-compulsive disorder (OCD) and obsessive-compulsive personality disorder.

X. ALCOHOLIC MICE & SOBER MICE (PP. 2.41–2.43)

Years ago two genetic strains of mice were created - one strain loved alcohol, the other hated alcohol.

When the alcohol-loving mice, whose genetics made them prefer alcohol were given unlimited access to alcohol, they drank themselves to death.

When the alcohol-hating mice were injected with high levels of alcohol, they preferred alcohol after a few weeks.

Another group of the alcohol-hating mice were subjected to environmental stress and within a few weeks, this group of sober mice also came to prefer alcohol over water.

Another group of alcohol-hating mice had vitamin B and some proteins subtracted from their diets. This limited nutrition also resulted in increased alcohol use after several months.

When the forced drinking, stress, and malnutrition were stopped, the once genetically sober mice did not return to their normal nondrinking habits. They had been transformed into alcohol-loving mice and if given the chance to drink, would be alcoholic mice.

When the brains of the four groups of mice were examined, all had similar brain cell changes and neurotransmitter imbalances that made them prefer alcohol even though they were born with different neurochemical balances.

XI. COMPULSION CURVES (PP. 2.43–2.45)

Compulsion/susceptibility help explain the connection between heredity, environment and the use of psychoactive drugs or compulsive behaviors. Each person is born with a different genetic susceptibility. The contribution of heredity to drug addiction is from 30% to 60%.
The susceptibility to addiction is further molded by environment. A person may have experienced low, medium, or high environmental contributions toward a susceptibility to drug addiction.

The final factor that pushes a person towards abuse and addiction is the use of psychoactive drugs or the practice of compulsive behaviors. The drugs that push the hardest and the quickest toward addiction are (from fastest to slowest):

- smoking tobacco, crack, heroin;
- injecting heroin and meth;
- snorting cocaine,
- ingesting opioid painkillers, amphetamines, and sedative hypnotics;
- drinking alcohol,
- smoking marijuana,

When use stops, an individual drops below critical susceptibility but they have a higher risk of relapse. The addiction has permanently altered their brain cells and circuitry.

If stress continues and the person remains near maximum susceptibility, just one drink, snort, bet, or piece of cake can retrigger compulsive use. If stress is reduced, environmental cues are avoided, attendance at self-help groups is routine and addiction memories are overcome, a person has a chance at continued recovery.

**XII. CONCLUSIONS (P. 2.45)**

Recent research shows, through brain imaging and a variety of other research techniques, that there are actual chemical and anatomical changes that force a person into compulsive behavior. Irresistible cravings and messages are permanently imprinted on the brain in emotionally charged addiction memories created by the excessive use of psychoactive drugs over a period of time.

It is necessary to understand these physiological and psychological changes and devise strategies that take these neurochemical changes into account; however, any study of addiction should focus on the totality of people’s lives.
Chapter 2 - HEREDITY, ENVIRONMENT, PSYCHOACTIVE DRUGS

Classroom or Small Group Discussion Topics

1. Discuss the different methods of introducing drugs into the body and the factors that would make someone choose one method or another.

2. As a class, list the human functions controlled by the old brain. Give reasons why they are old-brain functions rather than new-brain functions.

3. Discuss the evolutionary functions of the reward/control pathway in animals and humans and how it operates as a survival mechanism.

4. Describe how a message is sent from a sensory organ, to the brain, and then to another part of the body.

5. Describe, in detail, how a message crosses a synaptic gap.

6. Describe the difference between what cocaine does at a synapse and what heroin does at a synapse.

7. List and discuss natural activities that create an effect similar to various psychoactive drugs.

8. Discuss how a desired effect of a drug can also be an unwanted effect in a different situation (e.g., a painkiller such as codeine deadens pain but also can keep the person from sensing damage that could be aggravated by exercise.).

9. Think about food you regularly eat (sweets, spicy flavors, carbs) and how your capacity for use (tolerance) may have increased over time and then compare that to the increase in tolerance for psychoactive drugs.

10. Ask the students to identify an activity they or a friend pursue to excess and describe the process from experimenting with the behavior, up through the levels of use, and finally to an obsession with the activity.
Chapter 2 - HEREDITY, ENVIRONMENT, PSYCHOACTIVE DRUGS

Critical Thinking & Class Exercises

1. Divide the class into five groups and ask each group to determine ways
   • experimenters
   • social/recreational users
   • habitual users
   • abusers
   • addicts
   would acquire (a.) an illicit drug, (b.) a legal or licit substance used
   illegally (alcohol for underage drinkers, recreational use of prescription
   drugs)

2. Ask students to interview a friend or relative and ask the interview
   subjects to describe their physical and mental feelings (a.) after
   drinking coffee/tea/cola (stimulant), (b.) after a cigarette (stimulant),
   and/or (c.) after drinking alcohol. Compare the reactions for each
   stimulant such as heart rate, alertness, physical coordination, clarity of
   thought, and problem-solving abilities.

3. Ask students to make a list of five heredity factors and five
   environmental factors that might make them more susceptible to drug
   abuse. Then list five heredity factors and five environmental factors
   that would make them less susceptible. (if this is too personal – the
   exercise could focus on general factors – What would make a person
   susceptible…)

4. Have the students redraw the reward/control pathway on page 2.17
   (Figure 2-8) and briefly describe the three phases of brain activity that
   comprise the reward/control pathway and label the specific areas that
   are involved at each step.

5. Have small groups discuss and then report to the class the following:
   What drugs are most attractive to people in their age group, and why?
   What drugs are most attractive to people in their home community,
   and why?