

PowerLecture:
Chapter 34
Integration and Control: Nervous System
Section 34.0: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.0: NIDA—Club Drugs
- Section 34.0: The Lure of Ecstasy. Hannah Beech et al. *Time International*, Nov. 13, 2000.

How Would You Vote?

The following is the question for this chapter. See national results below.

- Should we sentence drug users to treatment programs instead of jail?

Impacts, Issues: In Pursuit of Ecstasy

- Ecstasy is a psychoactive drug that makes you feel socially accepted, sharpens the senses, and relieves anxiety
- It can also result in soaring blood pressure, elevated temperatures, organ failure, and death

Impacts, Issues: In Pursuit of Ecstasy

- The active ingredient is MDMA, which causes the brain to release too much serotonin, overstimulating target cells
- Depleted serotonin levels don't rebound quickly, and can result in concentration loss, memory problems, and depression

Section 34.1: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.1: FlyBrain
- Section 34.1: Escape from Stupidworld (evolution of brains). Christopher Wills. *Discover*, Aug. 1993.

Line of Communication
Invertebrate Nervous Systems

- All animals except sponges have some sort of nervous system

- Nerve cells are oriented relative to one another in signal-conducting and information-processing highways

Nerve Net

- Diffuse mesh of nerve cells that take part in simple reflex pathways
- Nerve cells interact with sensory and contractile cells

Bilateral Nervous Systems

Evolution of Nervous Systems

- Bilateral nervous system may have evolved from nerve nets
- Most bilateral animals have local nerve nets in some parts of the body
- The bilateral planula larva of some cnidarians resembles a flatworm

Vertebrate Nervous Systems

- Earliest fishlike vertebrates had a hollow, tubular nerve cord
- Modification and expansion of nerve cord produced spinal cord and brain
- Nerve cord persists in vertebrate embryos as a neural tube

Communication Lines

Section 34.2: Weblinks and InfoTrac

See the **latest Weblinks** and **InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 34.2: [Clinical Neurophysiology Links](#)
- Section 34.2: [SynapseWeb](#)
- Section 34.2: [All Fired Up \(synchro-nized neural firing = brain waves\). Bruce Bower. *Science News*, Feb. 21, 1998.](#)
- Section 34.2: [Rebuilding the Brain \(neural-cell transplants\). *Business Week*, Feb. 8, 1999.](#)

Neurons

- Basic units of communication in nearly all nervous systems
- Monitor information in and around the body and issue commands for responsive actions

Three Classes of Neurons

- Sensory neurons
- Interneurons
- Motor neurons

Structure of a Neuron

Resting Potential

- Charge difference across the plasma membrane of a neuron
- Fluid just outside cell is more negatively charged than fluid inside
- Potential is measured in millivolts
- Resting potential is usually about -70mv

How Ions Move across Membrane

Pumping and Leaking

Ion Concentrations at

Resting Potential

- Potassium (K^+)
 - Higher inside than outside
- Sodium (Na^+)
 - Higher outside than inside

Section 34.3: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 34.3: Wikipedia—Action Potential
- Section 34.3: What Makes Brain Neurons Run? (aerobic vs. anaerobic hypotheses). Marcia Barinaga. *Science*, Apr. 11, 1997.

Action Potential

- A transitory reversal in membrane potential
- Voltage change causes voltage-gated channels in the membrane to open
- Inside of neuron briefly becomes more positive than outside

Action Potential

Positive Feedback

All or Nothing

- All action potentials are the same size
- If stimulation is below threshold level, no action potential occurs
- If it is above threshold level, cell is always depolarized to the same level

Repolarization

- Once peak depolarization is reached, Na^+ gates close and K^+ gates open
- Movement of K^+ out of cell repolarizes the cell
- The inside of the cell once again becomes more negative than the outside

Section 34.4: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 34.4: My Little Spontaneous Blips (first observations of neurotransmitters in action, Bernard Katz). John Heuser. *Science*, May 23, 2003.

Propagation of
Action Potentials

- An action potential in one part of an axon brings a neighboring region to threshold

- Action potential occurs in one patch of membrane after another

Chemical Synapse

- Gap between the terminal ending of an axon and the input zone of another cell

Synaptic Transmission

- Action potential in axon ending of presynaptic cell causes voltage-gated calcium channels to open
- Flow of calcium into presynaptic cell causes release of neurotransmitter into synaptic cleft

Synaptic Transmission

- Neurotransmitter diffuses across cleft and binds to receptors on membrane of postsynaptic cell
- Binding of neurotransmitter to receptors opens ion channels in the membrane of postsynaptic cell

Ion Gates Open
Synaptic Integration

Multiple Sclerosis

- A condition in which nerve fibers lose their myelin
- Slows conduction
- Symptoms include visual problems, numbness, muscle weakness, and fatigue

Section 34.5: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 34.5: List of Psychiatric Drugs and Further Resources

- Section 34.5: Biochemistry of Neurotransmitters

- Section 34.5: Dopamine: The Plunge of Pleasure. Deborah Blum. *Psychology Today*, Sept.–Oct. 1997.

- Section 34.5: Fetal Attraction (fetal tissue transplant treatment for Parkinson's disease). Jeff Goldberg. *Discover*, July 1995.

Neurotransmitters

- ACh
 - Norepinephrine
 - Epinephrine
 - Dopamine
 - Serotonin
 - GABA
-
- Derived from amino acids

Neuropeptides

- Neuromodulators – magnify or reduce the effects of neurotransmitters
 - substance P
 - enkephalins
 - endorphins

Section 34.6: Weblinks and InfoTrac

See the **latest Weblinks** and **InfoTrac articles** for this chapter online or click **highlighted articles below (articles subject to change)**

- Section 34.6: The Microglia Home Page
- Section 34.6: Astrocytes—Neural Stem Cells
- Section 34.6: Mysterious Cells Found in the Brain of a Genius (unusual amount of glia in Einstein's brain). R. Douglas Fields. *Odyssey*, Oct. 2004.

Neuroglia

- Make up more than half the volume of the vertebrate nervous system
- A variety of cells that metabolically assist, structurally support, and protect the neurons

Growth Factor

- Growth factor is secreted by one cell and signals a receptor cell to divide or differentiate
- After they mature, neurons no longer undergo mitosis, but growth factor promotes more synaptic connections with neighboring cells

Section 34.7: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below** (articles subject to change)

- Section 34.7: The Nonverbal Dictionary of Gestures, Signs, & Body Language Cues
- Section 34.7: Newborn Reflexes: What Every Parent Needs to Know about Why Babies Do What They Do. Mary Arrigo. *Parenting*, Nov. 1, 2002.

Nerve

- A bundle of axons enclosed within a connective tissue sheath

Myelin Sheath

Reflexes

- Automatic movements made in response to stimuli
- In the simplest reflex arcs, sensory neurons synapse directly on motor neurons
- Most reflexes involve an interneuron

Stretch Reflex

Section 34.8: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online or click **highlighted articles below** (articles subject to change)

- Section 34.8: Explore the Brain and Spinal Cord
- Section 34.8: Spinal Cord Research Centre
- Section 34.8: Saving Shattered Spines (“miracle drug” Sygen). Jim Wilson. *Popular Mechanics*, Mar. 1999.
- Section 34.8: Pain, Pain, Go Away (severing part of spinal cord to block pain). Sarah Simpson. *Science News*, Feb. 13, 1999.

Central and Peripheral Nervous Systems

- Central nervous system (CNS)
 - Brain
 - Spinal cord
- Peripheral nervous system
 - Nerves that thread through the body

Peripheral Nervous System

- Somatic nerves
 - Motor functions
 - (Shown in green)
- Autonomic nerves
 - Visceral functions
 - (Shown in red)

Two Types of
Autonomic Nerves

- Sympathetic
- Parasympathetic
- Most organs receive input from both
- Usually have opposite effects on organ

Sympathetic Nerves

- Originate in the thoracic and lumbar regions of the spinal cord
- Ganglia are near the spinal cord
- Promote responses that prepare the body for stress or physical activity (fight-or-flight response)

Parasympathetic Nerves

- Originate in the brain and the sacral region of the spinal cord
- Ganglia are in walls of organs
- Promote housekeeping responses such as digestion

Both Systems Are Usually Active

- Most organs are continually receiving both sympathetic and parasympathetic stimulation
- For example, sympathetic nerves signal heart to speed up; parasympathetic stimulate it to slow down
- Which dominates depends on situation

Function of the Spinal Cord

- Expressway for signals between brain and peripheral nerves
- Sensory and motor neurons make direct reflex connections in the spinal cord
- Spinal reflexes do not involve the brain

Structure of the Spinal Cord

Section 34.9: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.9: [The Whole Brain Atlas](#)
- Section 34.9: [Comparative Mammalian Brain Collections](#)
- Section 34.9: [Breaching the Brain's Security System \(blood-brain barrier\). Beatrice Trum Hunter. *Consumers' Research Magazine*, Feb. 2001.](#)

Development of the Brain

- Brain develops from a hollow neural tube
- Forebrain, midbrain, and hindbrain form from three successive regions of tube
- Brain stem is tissue that evolved first and develops first in all three regions

Functional Regions

- Expansion and modification of the dorsal nerve cord produced functionally distinct regions

Divisions of Brain

Vertebrate Brains Cerebrospinal Fluid

- Surrounds the spinal cord
- Fills ventricles within the brain
- Blood-brain barrier controls which solutes enter the cerebrospinal fluid

Section 34.10: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.10: Mapping the Motor Cortex
- Section 34.10: Society for Neuroscience—Brain Briefings
- Section 34.10: Neuroscience Tutorial
- Section 34.10: Kernel of Fear (amygdala). Mark Caldwell. *Discover*; June 1995.
- Section 34.10: Hans Berger: From Psychic Energy to the EEG. David Millett. *Perspectives in Biology and Medicine*, Autumn 2001.

Reticular Formation

- Mesh of interneurons extends from top of spinal cord, through brain stem, and into higher integrating centers of cerebral cortex

Anatomy of the Cerebrum

- Largest and most complex part of human brain
- Outer layer (cerebral cortex) is highly folded
- A longitudinal fissure divides cerebrum into left and right hemispheres

Lobes of the Cerebrum

Limbic System

- Controls emotions and has role in memory

Section 34.11: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.11: [The Roger Sperry Site](#)
- Section 34.11: [Nobel Museum—The Split Brain Experiments](#)
- Section 34.11: [Mind with a Double Brain. Ronald Puccetti. *The British Journal for the Philosophy of Science*, Dec. 1993.](#)
- Section 34.11: [Lobotomy's Back \(history of psychosurgery\). Frank Vertosick. *Discover*, Oct. 1997.](#)

Sperry's Split Brain Expts.

- Corpus collosum severed
 - No communication between hemispheres
- Section 34.12: Weblinks and InfoTrac

See the [latest Weblinks](#) and [InfoTrac articles](#) for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.12: [The Memory Exhibition](#)
- Section 34.12: [Mnemonics & Simonides' The Art of Memory](#)
- Section 34.12: [What Is Déjà Vu?](#)
- Section 34.12: [False Memory Syndrome Foundation](#)
- Section 34.12: [Million Cell Memories. Bruce Bower. *Science News*, Nov. 15, 1986.](#)
- Section 34.12: [Sleep, Memory, and Learning. Patricia Blissitt. *Journal of Neuroscience Nursing*, Aug. 2001.](#)
- Section 34.12: [The Man Who Lost Himself \(amnesia\). *World Press Review*, June 1997.](#)
- Section 34.12: [Learning to Forget \(post-traumatic stress drug\). Greg Miller. *Science*, Apr. 2, 2004.](#)

Memory

- Brain's capacity to store and retrieve information about past sensory input
- Stored in stages
 - Temporary storage in cerebral cortex
 - Short-term memory
 - Long-term memory

Section 34.13: Weblinks and InfoTrac

See the [latest Weblinks](#) and [InfoTrac articles](#) for this chapter online or click highlighted articles below (articles subject to change)

- Section 34.13: [Drugs and the Brain Tutorial](#)
- Section 34.13: [Drugs, Brains and Behavior Online Book](#)
- Section 34.13: [Alkaloids—Plants that Make You Loco](#)

- Section 34.13: Addiction and the Brain. Tabitha Powledge. *BioScience*, July 1999.
- Section 34.13: What Hallucinogens Can Do to Your Brain. *Current Health 2*, Apr. 2000.
- Section 34.13: Marijuana and the Brain: Scientists Discover the Brain's Own THC. Kathy Fackelmann. *Science News*, Feb. 6, 1993.

Drugs and Addiction

- A drug is a substance introduced into the body to provoke a specific physiological response
- In addiction, a drug assumes an “essential” biochemical role in the body

Stimulants

- Increase alertness and body activity, then cause depression
 - Caffeine
 - Nicotine - mimics acetylcholine
 - Cocaine - blocks neurotransmitters reuptake
 - Amphetamines & Ecstasy - induce dopamine release

Depressants and Hypnotics

- Lower activity of nerves and parts of the brain
 - Barbiturates
 - Alcohol - acts directly on the plasma membrane to alter cell function

Analgesis

- Pain relievers
- Natural - endorphins and enkephalins
- Narcotic - codeine and heroin
 - among the most addictive drugs

Hallucinogens and Marijuana

- Skew sensory perception by interfering with action of neurotransmitters
- LSD affects action of serotonin
- Marijuana is a depressant at low dose; it can also cause disorientation, anxiety, delusion, and hallucinations

Teen Brain

- Prefrontal cortex is still developing
- Amygdala undergoing growth spurt
- Increased need for sleep