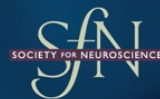


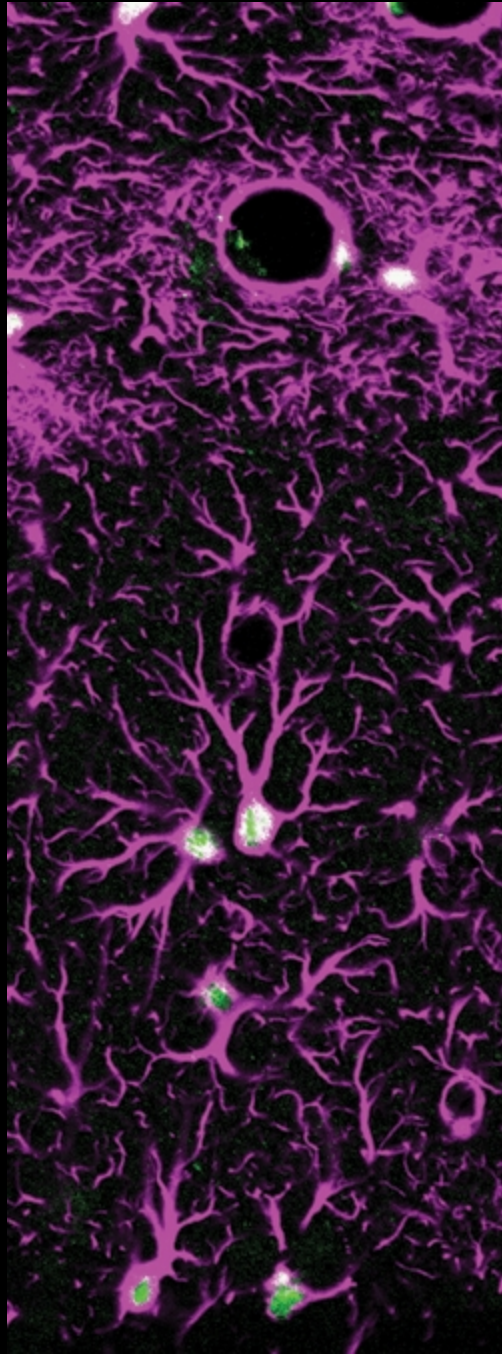
Neuroscience Core Concepts

THE ESSENTIAL PRINCIPLES OF NEUROSCIENCE



For more neuroscience education resources, please visit

www.sfn.org/nerve



What Are Neuroscience Core Concepts?

Neuroscience Core Concepts offer fundamental principles that one should know about the brain and nervous system, the most complex living structure knowing in the universe.

A vertical rectangular image on the left side of the slide showing a microscopic view of brain tissue. The tissue is stained with a green fluorescent dye, highlighting the complex network of neurons and their branching processes. Several cell bodies (soma) are visible, some with prominent nuclei. The background is dark, making the green-stained structures stand out.

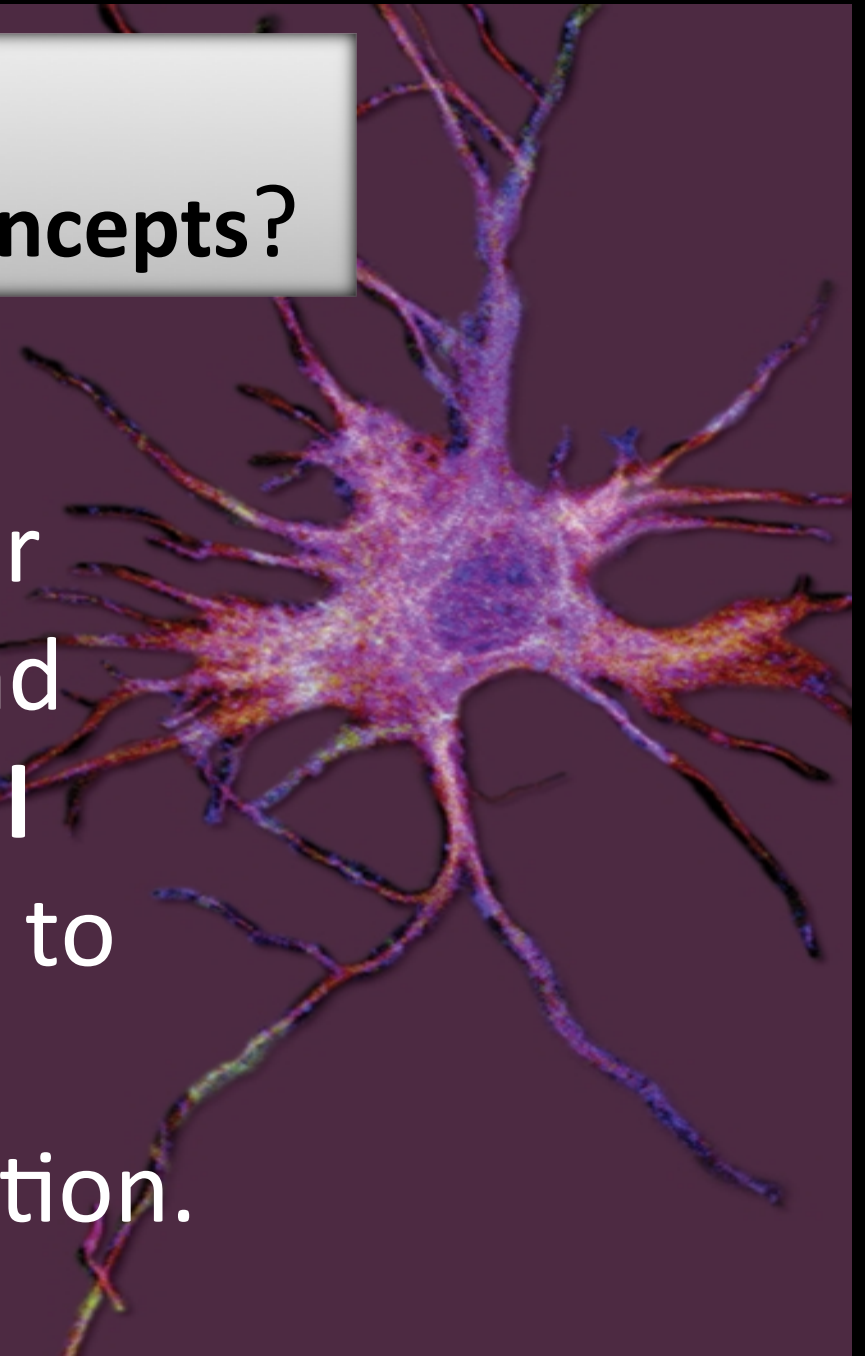
What Are Neuroscience Core Concepts?

A practical resource about:

- How your brain works and how it is formed.
- How it guides you through the changes in life.
- Why it is important to increase understanding of the brain.

What Are Neuroscience Core Concepts?

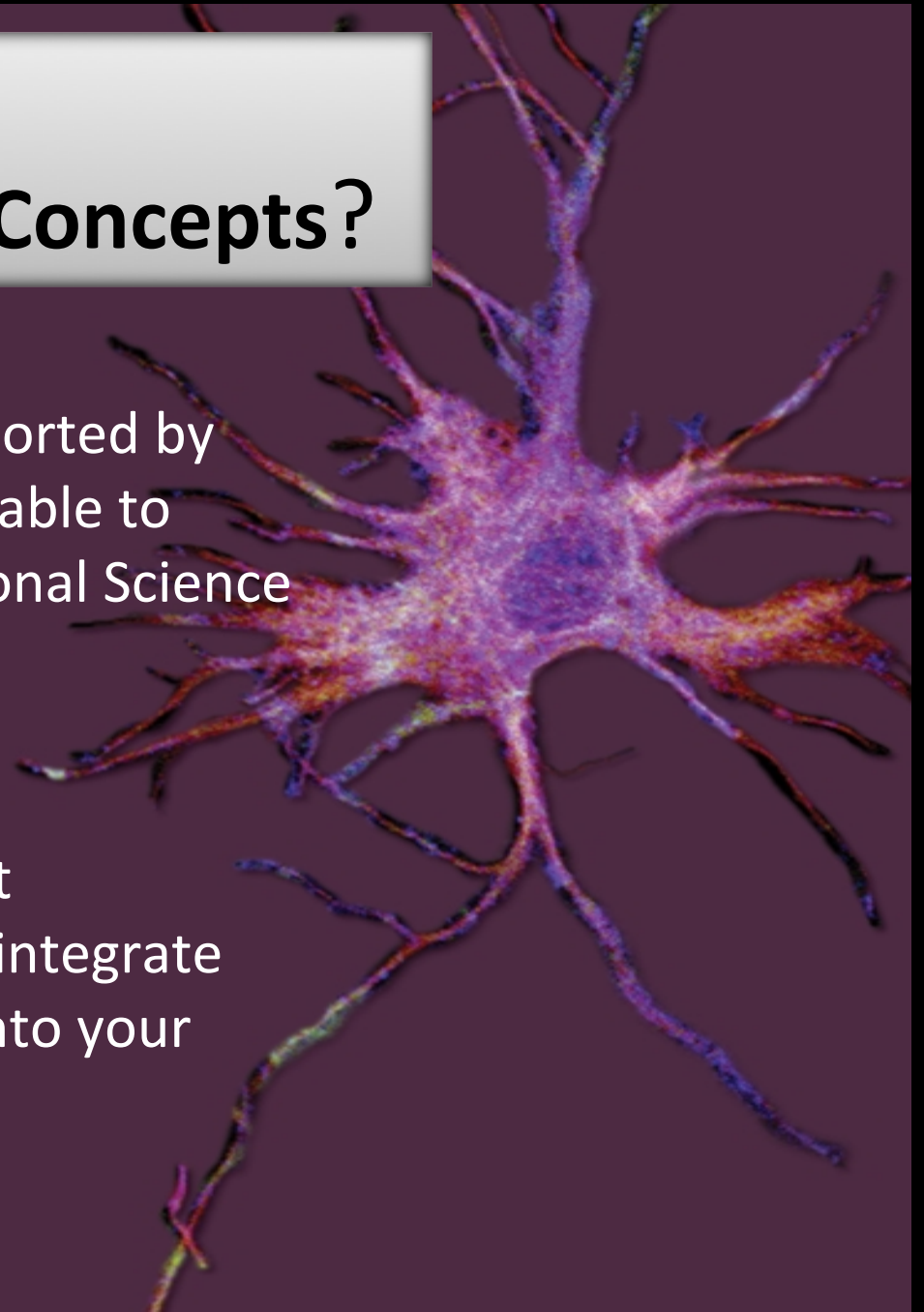
Eight concepts are organized within four “**mega-concepts**” and contain **fundamental principles** that serve to stimulate further thinking and exploration.



What Are Neuroscience Core Concepts?

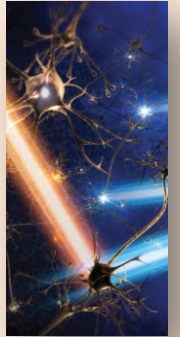
Each essential principle is supported by fundamental concepts comparable to those underlying the U.S. National Science Education Standards (NSES).

Consult the Overview Matrix at www.sfn.org/coreconcepts to integrate Neuroscience Core Concepts into your curriculum.



**The Nervous System
Controls and Responds
to Body Functions and
Directs Behavior**

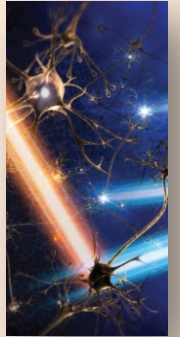




1. **The brain is the body's most complex organ.**

- a. There are a hundred billion neurons in the human brain, all of which are in use.
- b. Each neuron communicates with many other neurons to form circuits and share information.
- c. Proper nervous system function involves coordinated action of neurons in many brain regions.
- d. The nervous system influences and is influenced by all other body systems (e.g., cardiovascular, endocrine, gastrointestinal and immune systems).
- e. Humans have a complex nervous system that evolved from a simpler one.
- f. This complex organ can malfunction in many ways, leading to disorders that have an enormous social and economic impact.

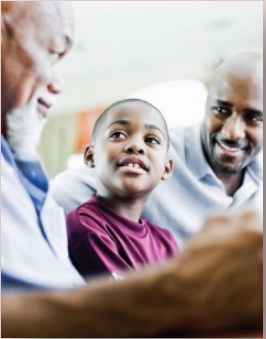
2. Neurons communicate using both electrical and chemical signals.



- a. Sensory stimuli are converted into electrical signals.
- b. Action potentials are electrical signals carried along neurons.
- c. Synapses are chemical or electrical junctions that allow electrical signals to pass from neurons to other cells.
- d. Electrical signals in muscles cause contraction and movement.
- e. Changes in the amount of activity at a synapse can enhance or reduce its function.
- f. Communication between neurons is strengthened or weakened by an individual's activities, such as exercise, stress, and drug use.
- g. All perceptions, thoughts, and behaviors result from combinations of signals among neurons.



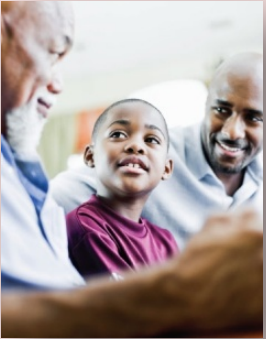
**Nervous System
Structure and Function
Are Determined by Both
Genes and Environment
Throughout Life**



Nervous System Structure and Function Are Determined by Both Genes and Environment Throughout Life

3. Genetically determined circuits are the foundation of the nervous system.

- a. Neuronal circuits are formed by genetic programs during embryonic development and modified through interactions with the internal and external environment.
- b. *Sensory* circuits (sight, touch, hearing, smell, taste) bring information to the nervous system, whereas *motor* circuits send information to muscles and glands.
- c. The simplest circuit is a reflex, in which a sensory stimulus directly triggers an immediate motor response.
- d. Complex responses occur when the brain integrates information from many brain circuits to generate a response.
- e. Simple and complex interactions among neurons take place on time scales ranging from milliseconds to months.
- f. The brain is organized to recognize sensations, initiate behaviors, and store and access memories that can last a lifetime.



Nervous System Structure and Function Are Determined by Both Genes and Environment Throughout Life

4. Life experiences change the nervous system.

- a. Differences in genes and environments make the brain of each animal unique.
- b. Most neurons are generated early in development and survive for life.
- c. Some injuries harm nerve cells, but the brain often recovers from stress, damage, or disease.
- d. Continuously challenging the brain with physical and mental activity helps maintain its structure and function — “use it or lose it.”
- e. Peripheral neurons have greater ability to regrow after injury than neurons in the brain and spinal cord.
- f. Neuronal death is a natural part of development and aging.
- g. Some neurons continue to be generated throughout life and their production is regulated by hormones and experience.



The Brain is the
Foundation of the Mind

5. Intelligence arises as the brain reasons, plans, and solves problems.



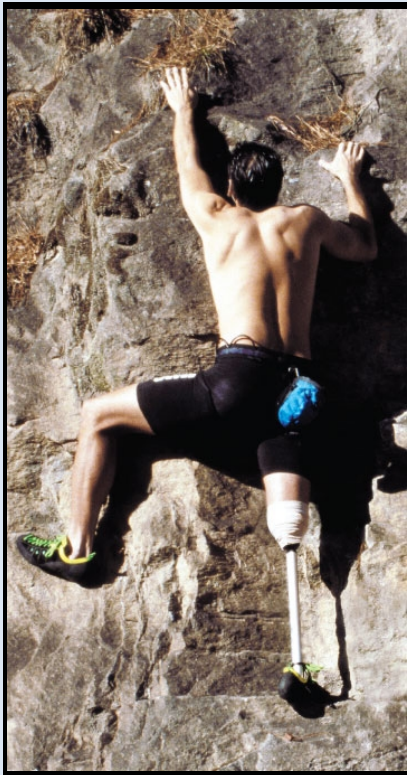
- a. The brain makes sense of the world by using all available information, including senses, emotions, instincts and remembered experiences.
- b. Emotions are based on value judgments made by our brains and are manifested by feelings as basic as love and anger and as complex as empathy and hate.
- c. The brain learns from experiences and makes predictions about best actions in response to present and future challenges.
- d. Consciousness depends on normal activity of the brain.

6. The brain makes it possible to communicate knowledge through language.



- a. Languages are acquired early in development and facilitate information exchange and creative thought.
- b. Communication can create and solve many of the most pressing problems humankind faces.

Research Leads To Understanding that Is Essential for Development of Therapies for Nervous System Disorders





Research Leads To Understanding that Is Essential for Development of Therapies for Nervous System Disorders

7. The human brain endows us with a natural curiosity to understand how the world works.

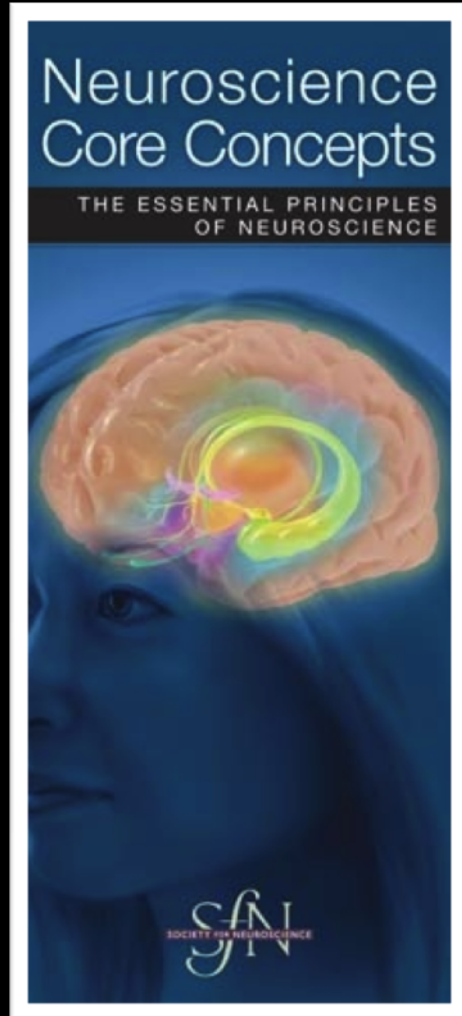
- a. The nervous system can be studied at many levels, from complex behaviors such as speech or learning, to the interactions among individual molecules.
- b. Research can ultimately inform us about mind, intelligence, imagination, and consciousness.
- c. Curiosity leads us to unexpected and surprising discoveries that can benefit humanity.



Research Leads To Understanding that Is Essential for Development of Therapies for Nervous System Disorders

8. Fundamental discoveries promote healthy living and treatment of disease.

- a. Experiments on animals play a central role in providing insights about the human brain and in helping to make healthy lifestyle choices, prevent diseases, and find cures for disorders.
- b. Research on humans is an essential final step before new treatments are introduced to prevent or cure disorders.
- c. Neuroscience research has formed the basis for significant progress in treating a large number of disorders.
- d. Finding cures for disorders of the nervous system is a social imperative.



The concepts were developed with leadership from the Public Education and Communication Committee of the Society for Neuroscience.

In January 2007, more than a year of development began, including extensive consultation, review, and refinement by hundreds of neuroscientists and educators nationwide.

This constitutes a living document that will be updated as new information becomes available.

For more
neuroscience
education resources:

www.sfn.org/NERVE

