



The Root of Thought

Unlocking Glia

The Brain Cell That Will Help Us Sharpen Our Wits,
Heal Injury, and Treat Brain Disease

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Cities and highways

Back in the 1960s, it was discovered that glial cells are 90 percent of the brain. Neurons make up 10 percent. One would think that as a result of this revelation, the conclusion reached would have been that glial cells function as a main component of the nervous system. But it wasn't. The conclusion was that we use only 10 percent of our brain.

From an early age, we are taught that the major cell in the brain is the neuron. We are also taught that neurons hold all the information in the brain. Even through graduate-level studies, the central tenant of neuronal importance is the basis of the study of neuroscience. But the Neuron Doctrine has become more religion than scientific truth, explaining away even the most blatant facts with assertions such as, "We use only 10 percent of our brain."

However, no sustainable argument or discovery has been made to give insight to where our thoughts come from, where our imagination resides, our dreams ignite, and how creativity burgeons. These are mysteries that have been explained with ideas such as "random neuronal firing" or "interconnectibility." But the truth is that the neuron is the least likely cell in the brain for the root of thought.

Until recently, glia have been considered the structural elements to the active neurons, like void space with no purpose except to hold the brain together—the nuts, bolts, and the frame of the engine of our minds.

The importance of the neuron is being aggressively challenged in the field. The recovery from brain injury, the cause of degenerative diseases of the brain, the treatments for psychiatric disorders, and an understanding of human intelligence can be fully realized only through the study of glia.

The surge in glial interest is due to three main reasons. First, glia signal to each other in a manner conducive to storage of information. Second, glia have long been known to be the cellular makeup of most brain tumors. Third, researchers now know glia are the adult stem cells in the brain.

It was once thought that our brains develop in the womb and during early childhood, and then remained in this state until we died. It is now known that we regenerate cells throughout adulthood. The stem cells of the brain are glia, which can reproduce themselves and neurons if needed.

Glia can also regenerate locally in order to store more information. One of the most fascinating studies in the last 30 years was the analysis of Albert Einstein's brain. When markers for different types of cells were analyzed, Einstein's brain was discovered to contain significantly more glia than normal brains in the left angular gyrus, an area thought to be responsible for mathematical processing and language.

If glia are the libraries for information storage in the brain, and assuming humans have the highest intelligence, then lower life forms should have less glia. One of the most striking research events has been the discovery of a single glial cell for every 30 neurons in the leech. This single glial cell receives neuronal sensory input and controls neuronal firing to the body. As we move up the evolutionary ladder, in a widely researched worm, *Caenorhabditis elegans*, glia are 16 percent of the nervous system. The fruit fly's brain has about 20 percent glia. In rodents such as mice and rats, glia make up 60 percent of the nervous system. The nervous system of the chimpanzee has 80 percent glia, with the human at 90 percent. The ratio of glia to neurons increases with our definition of intelligence.

Not only does the ratio of glia to neurons increase through evolution, but so does the size of the glia. Astroglial cells in the human have a volume 27 times greater than the same cells in the mouse's brain.

The folded cortex of humans is not noticed in other animals until you reach higher-level species such as cats, dolphins, and other primates. Humans have 35 percent more glia in its cortex than the chimpanzee.

This excess glia in our brains might explain the fact that humans are more susceptible than other animals to develop degenerative diseases of the brain such as Alzheimer's and Parkinson's, which disrupt thought. In

fact, in all degenerative diseases of the brain, loss of sense of smell is the first sign before the onset of symptoms. The olfactory bulb is known to have the highest turnover of cells in the brain because of the nature of smell. It is ever changing, and our olfactory bulb has to adjust as such. Glia are the stem cells necessary for this turnover.

The study of degenerative diseases of the brain in most labs today focuses on proteins that aggregate in neurons, the byproduct of the disease. This is like thinking a pothole is the reason a road is falling apart.

When a mechanism for glial proliferation is overactive, glia turn cancerous. Almost all tumors of the brain are gliomas, which are comprised of glia. Is it possible that glial regeneration is a normal process of the brain that needs to remain at a constant level depending on the amount of information learned and integrated? Is it possible that when it is lacking, degenerative disease occurs, and when it is aggressive, a tumor grows?

Our brains were also always thought to lose neurons as we grow older. Upon further review, it has been shown that neuronal numbers remain the same, whereas increases and disruptions are seen in glia. And just recently, it has been revealed that glia communicate to themselves in electrical waves through extensive nets involving calcium ion influx. These influxes of calcium can spread locally through glial networks. It has also been shown that glia express the receptors necessary to receive basic input from neurons, as well as signal to neurons themselves.

Neurons communicate down long processes called axons. Neurons either fire or they don't. This is called the "all-or-nothing" phenomenon. Glia are much more complex. Their wavelike communication may be more conducive to fluid information processing.

What are neurons if glia process and store information? Since researchers know that glia signal to neurons, it would seem neurons are simply static cells that fire at the beck and call of glia to other glial areas, which need to be ignited to produce related thoughts.

For instance, if you, like the author, think about pizza, and then you think about mozzarella, which leads you to think about Italy, you are igniting three glial centers in your brain. To get from one center to the next, if they are a significant distance, you must connect through a neuron. When the glial center for mozzarella receives strong neural firing from the center for pizza, then it ignites and thinks about everything related to mozzarella in that glial center.

For a century, scientists have barely questioned the idea of the dominance of the neuron. Even today, it's not a stretch to say that 99 percent of the laboratories studying the brain around the world focus on neuronal research.

But, as will be seen, this is the equivalent of aliens landing on earth in southern California and arriving at the conclusion that the freeway between San Diego and Los Angeles is more important to explore than the cities themselves.

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Index

A

- acetylcholine, 23
- action potentials, 42
- Adenosine-5-triphosphate (ATP), 50
- adult neurogenesis, 84
- alcohol
 - effect on astrocytes, 118
 - effect on mammillary bodies, 139
- Aldini, Giovanni, 19
- all-or-nothing phenomenon, 3
- alpha-synuclein, 124-125
- ALS (Amyotrophic Lateral Sclerosis)
 - identification of, 122
 - problems with glutamate transporters in, 126
- Altman, Joseph, 84, 90
- Alvarez-Buylla, Arturo, 85, 89-93
- Alzheimer's Disease
 - identification of, 123
 - link with apoE gene, 125
 - protein deposits in neurons
 - observed in, 124-125
- Alzheimer, Alois, 123
- amphibians, ratio of glia to neurons in, 36
- amygdala, 151
- amyloid beta, 124, 127, 139
- amyloid tau, 124
- Amyotrophic Lateral Sclerosis.
 - See* ALS
- angiogenesis, 147
- angular gyrus, 104
- anions, 44
- aplysia, 83
- apoE gene, link with Alzheimer's Disease, 125
- APP, 139
- Araque, Alfonso, 117
- Aristophanes, 7
- Aristotle, 6
- aspartate, 56
- astrocytes
 - as area between sensory processing and motor output, 38-40
 - astrocyte reaction, 127
 - astrocyte-to-neuron ratio
 - of Albert Einstein, 101-108*
 - in psychiatric disorders, 115-116*

- calcium waves, 156
 - calcium as a cellular regulator*, 43-46
 - calcium puffs*, 49-51
 - calcium signaling*, 47-52
 - curvilinear pattern of movement*, 48-50
 - dreams as evidence of*, 111-114
 - effect of marijuana on*, 117-118
 - extracellular versus intracellular calcium*, 46
 - internal calcium stores*, 46
 - cortical gliogenesis in adults, 89-96
 - effect of alcohol on, 118
 - endfeet, 55
 - endoplasmic reticulum, 48
 - gap junctions, 47-48
 - glutamate-mediated
 - astrocyte-neuron signaling
 - astrocyte influence on axon outgrowth*, 62-63
 - glutamate concentration in astrocytes*, 60
 - overview*, 55-59
 - release of transmitters from astrocytes*, 60-62
 - glutamate receptors, 56
 - Golgi complex, 48
 - growth
 - in adulthood*, 71
 - in early childhood*, 71
 - importance of, 155-158
 - as mediators between sensory experiences and motor action, 41
 - mitochondria, 48
 - neuronal signaling and, 34, 38-40
 - nineteenth-century research
 - into, 33-34
 - overview, 34
 - pre- and post-natal development, 65-66, 69-71
 - reaction, 127
 - regenerative ability, 72-74, 85-87
 - relationship between quantity of astrocytes and ability for complex thinking, 101-110
 - relationship with consciousness, creativity, and imagination, 156-158
 - response to closed head injury, 136-141
 - role in processing recreational drugs, 116-119
 - self-sufficient nature of, 39
 - astrocytomas**, 147-148
 - ATP (Adenosine-5-triphosphate)**, 50
 - axons**, 3
 - astrocyte influence on axon outgrowth, 62-63
 - cutting to reduce seizures, 25
 - myelin, 32
 - postnatal development, 70
 - Wallerian degeneration, 139
- B**
- basal ganglia, 69, 124
 - batteries, invention of, 19
 - bees, ratio of glia to neurons in, 35
 - Bergmann glia, 34

bipolar disorder, 115

birds

- ability to learn to new songs, 85
- ratio of glia to neurons in, 36

Bliss, Tim, 84

Bois-Reymond, Emile du, 21-22

Botox (botulinum neurotoxin A),
ability to block astrocytic release
of transmitters, 60

boxing, 136

brain injury

- closed head injury
 - astrocytic response to, 136-141*
 - definition of, 135*
 - effect of protective helmets, 136*
- link to degenerative disease, 140
- open head injury
 - primary injury, 134*
 - secondary degeneration of
brain cells, 135*
- overview, 133
- research models, 140-141

brain tumors. *See* gliomas

BrdU (5-Bromodeoxyuridine), 90

Brightman, Milton, 47

Broca, Paul, 38

Broca's area, 149

Byron, Lord George Gordon, 20

C

Caenorhabditis elegans, ratio of glia
to neurons in, 2

caffeine, 116

Cajal, Santiago Ramón y, 9-13,
22, 138

calcium waves, 156

- calcium as a cellular regulator, 43-46
- calcium ion influx, 3
- calcium puffs, 49-51
- calcium signaling, 47-52
- curvilinear pattern of movement,
48-50
- dreams as evidence of, 111-114
- effect of marijuana on, 117-118
- extracellular versus intracellular
calcium, 46
- internal calcium stores, 46

cancer. *See* gliomas

Carlsson, Arvid, 123

Caton, Richard, 22

cellular regulation, role of calcium
in, 43-45

cephalopods, ratio of glia to
neurons in, 36

cerebrospinal fluid, ancient Roman
beliefs about, 6

Charcot, Jean-Martin, 122

Charcot-Marie-Tooth syndrome, 122

chimpanzees, ratio of glia to
neurons in, 2

cholesterol, synthesis by
astrocytes, 62

Cicero, 86

clinical depression, reduced number
of astrocytes in, 115

- closed head injury
 - astrocytic response to, 136-141
 - definition of, 135
 - effect of protective helmets, 136
 - research models, 140-141

cocaine, 118

conduction of electricity. *See*
electrophysiology

Confessions of an Opium-Eater
(Quincey), 118

Cornell-Bell, Ann H., 47

corpus callosum, 81

cortex

angular gyrus, 104

Broca's area, 149

cortical gliogenesis in adults, 89-97

cortical thinning process, 71-72

early research into, 25

left temporal cortex, 38

motor cortex, 38

parietal cortex, 38

visual cortex, 38, 72

curvilinear pattern of calcium

waves, 48-50

cytosol, 48

D

Darwin, Charles, 8

daydreaming, 114

Deep Brain Stimulation, 124

degenerative diseases of brain

Alzheimer's Disease

identification of, 123

link with apoE gene, 125

protein deposits in neurons

observed in, 124-125

Amyotrophic Lateral Sclerosis (ALS)

identification of, 122

problems with glutamate

transporters in, 126

astrocyte reaction in, 127

and inadequate turnover rate of
glial cells, 127-130

link to brain injury, 140

Parkinson's Disease

Deep Brain Stimulation, 124

identification of, 122

loss of substantia nigra in, 123

mutations in alpha-synuclein

observed in, 125

related nature of degenerative
diseases, 121-122

susceptibility to, 2-3

Deiters, Otto, 8, 33

dementia, 108

depolarization of glia, 43

depression, reduced number of
astrocytes in, 115

Descartes, 6-7

Deter, Auguste, 123

Diamond, Marian, 104

diffuse axonal injury. *See* closed
head injury

Dissertation on the Sensible and
Irritable Parts of Animals
(Franklin), 26

dopamine, 124

Down's Syndrome

reduction in synaptogenesis in, 70
and synaptic complexity, 100

dreams

daydreaming, 114

EEGs (electroencephalographs) of
brain activity during, 112

as evidence of sporadic calcium
waves, 111-114

in other species, 114

- overview, 111-112
- recurring dreams, 113
- relationship with experience, 113

Driving Mr. Albert: A Trip Across America with Einstein's Brain (Paterniti), 109

E

- early childhood brain
 - development, 71
- Ebbinghaus, Hermann, 79, 86
- Eccles, John, 24
- Eddington, Arthur Stanley, 103
- Edison, Thomas, 17
- EEGs (electroencephalographs) of dreams, 112
- Einstein, Albert, 2
 - astrocyte-to-neuron ratio, 101-108
 - fate of brain after death, 102-110
- Einstein's Brain (i), 106
- electrical conductance. *See*
 - electrophysiology
- electroencephalographs (EEGs) of dreams, 112
- electrophysiology
 - eighteenth-century research into, 16-17, 26
 - medical use of electricity in ancient Rome, 15
 - nineteenth-century research into, 18-22
 - twentieth-century research into, 23-25
- End of Days*, 106
- endfeet, 55
- endoplasmic reticulum, 48

- ependymal cells, 32
- Exner, Sigmund, 11
- extracellular calcium, 46

F

- Ferrier, David, 25
- Finkbeiner, Steven, 48
- 5-Bromodeoxyuridine (BrdU), 90
- flatworms, glia-to-neuron ratio in, 35
- Flourens, Pierre, 25, 80
- Frankenstein* (Shelley), 20
- Franklin square, 17
- Franklin, Benjamin, 17
- Freeman, Walter, 25
- Fritsch, Gustav, 22, 37
- Fritz, Gustav, 80
- frontal lobotomy, 25
- fruit flies, ratio of glia to neurons in, 2

G

- GABA, 56
- Gage, Fred, 85, 93
- Gage, Phineas, 134
- Galen, 6
- Galvani, Luigi, 17-19
- Gama, Jean-Pierre, 136
- gap junctions, 47-48
- Gehrig, Lou, 122
- GFAP (glial fibrillary acidic protein), 127, 146
- Gierke, Edgar von, 34
- Glees, Paul, 42
- glia
 - astrocytes. *See* astrocytes
 - Bergmann glia, 34

- and degenerative diseases of brain.
 - See* degenerative diseases of brain
- depolarization, 43
- ependymal cells, 32
- glia-to-neuron ratio and
 - corresponding behavior, 1
 - in amphibians*, 36
 - in birds*, 36
 - in cephalopods*, 36
 - in flatworms*, 35
 - in insects*, 35
 - in jellyfish*, 35
 - in leeches*, 35
 - in mammals*, 36-37
- gliomas
 - angiogenesis*, 147
 - astrocyte behavior in*, 152-153
 - astrocytomas*, 147-148
 - cognitive problems resulting from*, 148-151
 - glioblastoma multiform*, 146-148
 - glioblastomas*, 148
 - medullablastoma*, 149
 - overview*, 3, 145-146
- glutamate-mediated astrocyte-neuron signaling
 - astrocyte influence on axon outgrowth*, 62-63
 - glutamate concentration in astrocytes*, 60
 - overview*, 55-59
 - release of transmitters from astrocytes*, 60-62
- importance of, 2-4
- influence on hormone secretion, 62
- microglia, 32
- Müller cells, 31
- oligodendrocytes, 32
- origin of term, 7
- overview, 29
- radial glia, 66-67
- regenerative ability, 2
- Schwann cells, 32
- tanycytes, 32
- twentieth-century research
 - into, 42-43
- wavelike nature of
 - communication, 3
- glial fibrillary acidic protein (GFAP), 127, 146
- glioblastoma multiform, 146-148
- glioblastomas, 148
- gliomas
 - angiogenesis*, 147
 - astrocyte behavior in*, 152-153
 - astrocytomas*, 147-148
 - cognitive problems resulting from*, 148-151
 - glioblastoma multiform*, 146-148
 - glioblastomas*, 148
 - medullablastoma*, 149
 - overview*, 3, 145-146
- glutamate
 - and ALS (Amyotrophic Lateral Sclerosis), 126
 - receptors, 56
 - release from astrocytes, 56
- Goldman, Patricia, 66
- Golgi, Camillo, 8-13
- Golgi complex, 48
- Golgi stain, 8-10
- Gordon, George, Lord Byron, 20

H

habituation, 83
 Haller, Albrecht von, 26
 hallucinogens, 118
 Harvey, Thomas, 102-104, 107, 110
 Haydon, Philip G., 56-58
 Hebb, Donald, 37, 73, 82
 Hebbian philosophy of neuronal
 plasticity, 73
 helmets, 136
 Helmholtz, Hermann von, 7
 hemispheres of brain, 26
 Henle, Jakob, 33
 Herodotus, 7
 hippocampus, 81
 Hippocrates, 5
 history
 of electrophysiology
 eighteenth-century research
 into, 16-17, 26
 medical use of electricity in
 ancient Rome, 15
 nineteenth-century research
 into, 18-22
 twentieth-century research
 into, 23-25
 of neuroscience, 7-9, 12-13
 of neuroscientific concepts, 5-13
 Hitzig, Eduard, 22, 37, 80
 HM (memory-impaired patient),
 81-82
 Hodgkin, Alan, 23
 Hoover, J. Edgar, 104
 Hubel, David, 72
 Hull, Kevin, 106

Hunter, John, 16
 Huxley, Aldous, 24
 Huxley, Andrew, 24

I

imagination, passive versus
 active, 114
 improving memory, 79
 inositol triphosphate, 48-49
 insects, glia-to-neuron ratio in, 35
 intelligence versus learning, 85
 internal calcium stores, 46
 interneurons, prenatal
 development of, 69
 intracellular calcium, 46

J-K

James, William, 79
 jellyfish, glia-to-neuron ratio in, 35

 Kandel, Eric, 82-83
 Kennedy, Rosemary, 25
 Kennedy, Ted, 147
 Kettenmann, Helmet, 56
 Kimelberg, Harold, 56
 knee jerk reflex, 30
 Kolliker, Albrecht von, 8
 Korsakoff's syndrome, 139
 Krauss, Elliot, 110
 Kuffler, Stephen W., 42, 55

L

Lashley, Karl, 80
 learning. *See also* memory
 adult neurogenesis, 84
 compared to intelligence, 85

habituation, 83
 long-term potentiation (LTP),
 84-85
 reflexive learning, 80
 sensitization, 83
 synaptogenesis, 82
 leeches, glia-to-neuron ratio in,
 2, 35
 Leeuwenhoek, Anton von, 7
 left brain, 26
 left temporal cortex, 38
 Lewy Bodies, 124
 Lewy, Frederick, 124
 Leyden jar, 16-17
 limbic system, 69
 lithium, 115
 Littré, Alexis, 135
 lobotomy, 25
 localization of thought, twentieth
 century research into, 24-26
 Lømo, Terje, 84
 long- versus short-term memory,
 79-80
 long-term potentiation (LTP), 84-85
 Lou Gehrig's Disease. *See* ALS
 (Amyotrophic Lateral Sclerosis)
 Louis XIV, 16
 LSD, 118
 LTP (long-term potentiation),
 84-85
 Luria, Alexander, 134

M

Maladie de Charcot. *See* ALS
 (Amyotrophic Lateral Sclerosis)
 mammals, glia-to-neuron ratio
 in, 36-37

mammillary bodies, effect of alcohol
 on, 139
The Man with a Shattered World
 (Luria), 135
 manic-depression, 115
 marijuana, effect on calcium
 waves, 117-118
 Matteucci, Carlo, 20
 memory. *See also* learning
 biological basis of, 81-87
 adult neurogenesis, 84
 astrocyte regeneration, 85-87
 hippocampus, 81-82
 long-term potentiation (LTP),
 84-85
 nineteenth-century research,
 80-81
 synaptogenesis, 82
 improving, 79
 long- versus short-term
 memory, 79
 overview, 77
 personal nature of, 78
 plasticity, 79
Memory: A Contribution to
Experimental Psychology
 (Ebbinghaus), 79
 mescaline, 118
 mice, ratio of glia to neurons in, 2
 microglia, 32
 mitochondria, 48
 mnemonics, 79
 motor cortex, 38
 motor neurons, 31
 Müller cells, 31
 Müller, Heinrich, 31
 multiple sclerosis, 152

Murphy, Sean, 43

Musschenbroek, Pieter Van, 16

myelin, 32

N

Nedergaard, Maiken, 56

Nernst, Walther, 24

neuroglia, 34

Neuroglia: Morphology and Function
(Glees), 42

Neuron Doctrine, 12

weaknesses of, 38-39

neurons

all-or-nothing phenomenon, 3

astrocyte-to-neuron ratio
of Albert Einstein, 101-108
in psychiatric disorders,
115-116

basal ganglia, 124

communication between, 3

corpus callosum, 81

dependent nature of, 39

effect of environment on neuronal
wiring, 72

electrical conductance, 24.

See also electrophysiology

glia-to-neuron ratio and

corresponding behavior, 1-2

in amphibians, 36

in birds, 36

in cephalopods, 36

in flatworms, 35

in insects, 35

in jellyfish, 35

in leeches, 35

in mammals, 36-37

glutamate-mediated

astrocyte-neuron signaling

astrocyte influence on axon
outgrowth, 62-63

glutamate concentration in
astrocytes, 60

overview, 55-59

release of transmitters from
astrocytes, 60-62

Hebbian philosophy of neuronal
plasticity, 73

importance of, 1

motor neurons, 31

Neuron Doctrine, 12

weaknesses of, 38-39

overview, 30-31

Purkinje cells, 30

refractory period, 24

sensory neurons, 31

substantia nigra, 123

synapses, 100, 157

neuroscientific concepts, history
of, 5-13

nicotine, 116

Nobilli, Leopold, 20

Nottebohm, Fernando, 85, 89-91

O

octopi, glia-to-neuron ratio in, 36

oligodendrocytes, 32

gap junctions with astrocytes, 47

prenatal development, 69

open head injury

primary injury, 134

research models, 140-141

secondary degeneration of brain
cells, 135

The Organization of Behavior: A Neuropsychological Theory (Hebb), 37

Orkland, Richard K., 55

oxidative stress, 126

oxytocin, influence of glia on
oxytocin levels, 62

P

parietal cortex, 38

Parkinson, James, 122

Parkinson's Disease

Deep Brain Stimulation

treatment, 124

identification of, 122

loss of *substantia nigra* in, 123

mutations in alpha-synuclein

observed in, 125

Parpura, Vladimir, 56

passive imagination, 114

patellar reflex, 30

Paterniti, Michael, 110

Pavlov, Ivan, 80

Penfield, Wilder, 25, 37, 81

Pfrieger, Frank W., 62

physical conduction of electricity.

See electrophysiology

plasticity, 73, 79

The Poem of Hashish

(Baudelaire), 111

polyopic heautoscopy, 151

Positron Emission Tomography, 38

potassium ions, electric

potential of, 21

prenatal brain development, 65-66,
69-71

processes, 8

psilocybin, 118

psychiatric disorders, 115-116

psychological experiments on
memory, 79-80

Purkinje, Jan, 30

Purkinje cells, 30

Q-R

Quincey, Thomas de, 118

radial glia, 66-67

Rakic, Pasko, 66

rats, ratio of glia to neurons in, 2

recreational drugs, 116-119

recurring dreams, 113

Reese, Thomas S., 47

reflexive learning, 80

refractory period, 24

regenerative ability of astrocytes,
72-74

regenerative ability of glia, 2

Remak, Robert, 8

*Restoration of Function after Brain
Injury* (Luria), 134

retinal glia cells (Müller cells), 31

right brain, 26

Ringer, Sydney, 44

Roosevelt, Franklin, 104

Roosevelt, Teddy, 136

Rothstein, Jeffrey, 126

S

schizophrenia, 116

Schleich, Carl Ludwig, 11

Schulte, Max, 33

- Schwann, Theodore, 32
 Schwann cells, 32
 Seinfeld, Jerry, 136
 sensitization, 83
 sensory deprivation, 114
 sensory neurons, 31
 serotonin, 116
 serotonin reuptake inhibitors, 116
 Shelley, Mary, 20
 Shelley, Percy Bysshe, 20
 Sherrington, Charles Scott, 23
 short- versus long-term
 memory, 79-80
 signals
 calcium waves, 156
 calcium as a cellular regulator,
 43-46
 calcium ion influx, 3
 calcium puffs, 49-51
 calcium signaling, 47-52
 curvilinear pattern of
 movement, 48-50
 dreams as evidence of, 111-114
 effect of marijuana on, 117-118
 extracellular versus
 intracellular calcium, 46
 internal calcium stores, 46
 glutamate-mediated astrocyte-
 neuron signaling
 astrocyte influence on axon
 outgrowth, 62-63
 glutamate concentration in
 astrocytes, 60
 overview, 55-59
 release of transmitters from
 astrocytes, 60-62
- Simonides, 86
 Snowden, David, 108
 sodium ions, electric potential of, 21
 songbirds, ability to learn to new
 songs, 85
 Sonic Hedge Hog, 48
 Sperry, Roger, 26
 squid, glia-to-neuron ratio in, 36
 substantia nigra, 123
 Sugimoto, Kenji, 106
 susceptibility to degenerative
 diseases of brain, 2-3
 synapses, 23, 157
 synaptic elimination process, 100
 synaptogenesis, 70, 82
 Szilard, Leo, 103
- T**
- tanycytes, 32
 thymidine, 84
 toxins, ability to block astrocytic
 release of transmitters, 60
 transmitters, release from
 astrocytes, 60-62
 Tretiakoff, Konstantin, 123
 tripartite synapse theory, 58
 tumors. *See* gliomas
 Tyson, Mike, 155
- V**
- vasopressin, influence of glia
 on, 62
 Virchow, Rudolf, 7, 31
 visual cortex, 38, 72
 Volta, Alessandro, 18-19
 voltaic pile, 19

W-X-Y-Z

- Waldeyer, Gottfried von, 12
- Wallerian degeneration, 139
- Walsh, John, 16
- Weigert, Carl, 12
- Whitman, Walt, 23
- Wiesel, Torsten, 72
- withdrawal, 116

- Zimmerman, Harry, 102