Nervous System

Course
Medical Terminology

Unit X
Nervous System

Essential Question
What medical terms are associated with the nervous system?

TEKS
130.203 (c)
1 A-F
2A-C
3A-C
4A-B

Prior Student Learning
Basic understanding of roots, prefixes, and suffixes

Estimated time
4-7 hours

Rationale
Healthcare professionals must have a comprehensive medical vocabulary in order to communicate effectively with other health professionals. They should be able to use terminology of the nervous system to discuss common conditions and diseases.

Objectives
Upon completion of this lesson, the student will be able to:

- define and decipher common terms associated with the nervous system;
- identify the basic anatomy of the nervous system;
- analyze unfamiliar terms using the knowledge of word roots, suffixes and prefixes gained in the course; and
- research diseases which involve the nervous system

Engage
Mr. Smith comes in to Dr. Anderson's office, accompanied by his wife, complaining of memory problems. Is this just part of the natural aging process or is it something more serious?

Key Points

I. Nervous system words to know
   A. cerebr/o – cerebrum (brain)
   B. dur/o – dura mater (hard, tough)
   C. encephal/o – brain
   D. cephal/o – head
   E. myel/o – medulla (also marrow)
   F. myelin/o – myelin (Schwann cells)
   G. neur/o – nerve
   H. radic/o, radicul/o – nerve root
   I. psych/o – mind
   J. ment/o – mind
   K. -paresis – slight paralysis
   L. -plegia – paralysis, stroke
   M. gangli/o, ganglion – swelling, ganglion (pl=ganglia)
   N. mening/i, mening/o – meninges (membrane)
   O. esthesi/o – sensation
   P. phas/o – speech
   Q. poli/o – gray matter
   R. phren/o – mind (also diaphragm)
   S. scler/o – hard

II. Introduction
    A. The most highly organized system of the body
    B. A fast, complex communication system that regulates thoughts, emotions, movements, impressions, reasoning, learning, memory, and choices
    C. Basic Characteristics
        1. Master control system
        2. Master communication system
        3. Regulates and maintains homeostasis
    D. Functions
        1. Monitors change (stimuli) – sensory input
        2. Integrates impulses – integration
        3. Affects responses – motor output

III. Organization of the Nervous System
    A. CNS (Central Nervous System)
        1. The brain and spinal cord
        2. Integrates incoming pieces of sensory information, evaluates the information, and initiates the outgoing responses
        3. No potential for regeneration
    B. PNS (Peripheral Nervous System)
        1. Made of 12 pairs of cranial nerves and 31 pairs of spinal nerves
        2. Afferent (sensory) division
            a. Carries impulses toward the CNS
            b. Somatic (skin, skeletal muscles, and joints)
            c. Visceral (organs within the ventral cavity)
        3. Efferent (motor) division
            a. Somatic – carries information to the skeletal muscles (reflex and voluntary control)
            b. Autonomic – involuntary; regulates smooth muscles, cardiac muscle, and glands
                i. Sympathetic – exits the thoracic area of the spinal cord; involved in preparing the body for “fight or flight”
                ii. Parasympathetic – exits the cervical and lumbar areas of the spinal cord; coordinates the body’s normal resting activities (resting and digesting-repairing)

IV. Histology of Nervous Tissue
    A. Basic Characteristics
        1. Highly cellular
        2. Two types of cells – neurons and supporting cells (neuroglia)
    B. Neuroglia characteristics

1. A dense network of supporting cells for nerve tissue
2. Over 900 billion cells
3. Can replace themselves
4. glia = glue
5. Supportive scaffolding; insulation; neuron health and growth
6. Six types (four in the CNS, two in the PNS)
7. Tic douloureux – a painful disorder; supporting cells of fibers of the trigeminal nerve (main sensory nerve of the face) degenerate – touch sensations stimulate uninsulated pain fibers – agonizing pain with the softest touch

C. Neuroglia
   1. Astrocytes – star-shaped cells in the CNS
      a. Most abundant; cling to neurons and capillaries
      b. Make tight sheaths around the brain's capillaries forming the blood-brain barrier that regulates the passage of certain molecules into the brain
      c. Controls the chemical environment (leaked K+, recaptured/recycled neurotransmitters)
   2. Microglia – small, ovoid, thorny cells in the CNS; phagaocytic cells that fight infection by engulfing microbes
   3. Ependymal – squamous to columnar; some ciliated in the CNS
      a. Form thin sheaths that line the ventricles and spinal canal
      b. Help form the Cerebrospinal fluid (CSF)
      c. There is a permeable barrier between the CSF and the CNS
      d. Cilia circulate the CSF
   4. Oligodendrocytes – in the CNS
      a. Form myelin sheaths around axons of the CNS
      b. Forms "white matter" of the brain and spinal cord
      c. Multiple Sclerosis – a disease of the oligodendrocytes where hard lesions replace the myelin and affected areas are invaded by inflammatory cells; nerve conduction is impaired; chronic deterioration of the myelin of the CNS with periods of remission and relapse; causes: autoimmunity or viral
   5. Schwann cells – in the PNS
      a. Neurolemmocytes
      b. Form myelin sheaths around the axons of the PNS
      c. The area between the Schwann cells form gaps called the Nodes of Ranvier
      d. As each Schwan cell wraps around the axon, its nucleus and cytoplasm are squeezed to the perimeter to form the neurilemma (sheath of Schwann) which is essential for nerve regeneration

e. Also act as phagocytes (cell debris)

6. Satellite/attendant cells – in the PNS
    a. Surround neuron cell bodies within the ganglia
    b. Control the chemical environment

D. Neurons
1. Over 100 billion
2. Highly specialized
3. Send messages in the form of nerve impulses
4. Extreme longevity (>100 years)
5. Amitotic (no centrioles)
6. High metabolic rate
7. 3 functional components in common
    a. receptive/input regions
    b. conducting component/trigger zone
    c. secretory/output component

E. Neuron cell body
1. Nucleus
2. Cytoplasm – contains neurofibrils (convey impulses)
3. Nissl bodies – for protein synthesis; rough endoplasmic reticulum (ER)
4. No centrioles; therefore they cannot divide by mitosis
5. Axon
    a. A long, slender fiber that transmits impulses away from the cell body
    b. One per neuron
    c. Short, absent, or long (great toe – the lumbar region: three to four feet = longest cells in the body)
    d. The long ones are called nerve fibers
    e. The largest in diameter have the most rapid conduction
    f. The distal tip of the axon ends in a synaptic knob or end plate
6. Dendrites
    a. Short, tapering, diffusely branched (tree-like) fibers
    b. Carry impulses toward the cell body from sensory receptors or other axons

F. Myelin sheath
1. Whitish, fatty (protein lipoid), segmented covering of the axons
2. Myelinated fibers – conduct nerve impulses rapidly; electrical insulation
3. Unmyelinated fibers – conduct impulses slowly
4. White matter – myelinated sheaths around the axons of the PNS; gives the tissue a white color and forms myelinated nerves (axons = myelinated tracts)
5. Gray matter – concentrations of cell bodies and unmyelinated fibers (in the PNS = ganglia; in the CNS =

nuclei)

G. Nerves
    1. Bundles of PNS fibers held together by several layers of connective tissue
    2. Endoneurium – fibrous connective tissue surrounding each nerve fiber
    3. Perineurium – connective tissue holding together bundles of fibers
    4. Epineurium – fibrous tissue holding the whole nerve together

H. Synapse
    1. Space between nerve fibers; the place where nerve impulses are transmitted from one neuron to another
    2. The axonal terminal contains synaptic vesicles (membrane bound sacs containing neurotransmitters)
    3. The receptor region on the dendrite
    4. Synaptic cleft – microscopic gap that exists between the neurons

V. Neurons

A. Characteristics (see the Neuron Diagram)
    1. Excitability – the ability to react to a stimuli, physical or chemical
    2. Irritability – sensory adaptation; with prolonged stimulation, irritability is temporarily lost (i.e. smell)
    3. Conductivity – the ability to transmit an impulse
        a. Nonmyelinated fibers = 0.5-1 meter/sec (1 mph)
        b. Myelinated fibers = 80-130 meters/sec (300 mph)

B. Structural classification of neurons – the number of processes extending from cell bodies (see the Types Of Neurons Diagram)
    1. Multipolar – several (three or more) dendrites and one axon; most common; motor
    2. Bipolar – two processes; one axon and one dendrite at either end of the cell body; rare; retina of the eye, olfactory mucosa, and inner ear
    3. Unipolar/pseudounipolar – a single process; originates as bipolar then the processes fuse; a single short process from the cell body that divides like a T; ganglia of the PNS as sensory neurons

C. The functional classification of neurons – the direction in which the nerve impulse travels relative to the CNS
    1. Sensory/afferent – the dendrites are connected to receptors where stimulus is initiated in the skin/organs and carry an impulse toward the CNS; the axons are connected to other neuron dendrites; they are unipolar except for the bipolar neurons in special sense organs; cell bodies in sensory ganglia outside the CNS

a. Receptors – extroceptors (pain, temperature, touch); interoceptors (organ sensation); proprioceptors (muscle sense, position, movement)

2. Motor/Efferent – carry messages from the CNS to effectors; the dendrites are stimulated by other neurons and the axons are connected to effectors (muscles and glands); they are multipolar except for some in the autonomic nervous system (ANS)
3. Association/Interneurons – carry impulses from one neuron to another (afferent to efferent); found only in the CNS; lie between the sensory and motor neurons; shuttle signals; 99% of the neurons in the body

VI. Regeneration
- A. Neurons do not reproduce themselves, but they can regenerate new parts sometimes
- B. If a neuron is cut through a myelinated axon, the proximal portion may survive if the cell body is not damaged
- C. The distal portion will die (degenerate). Macrophages move into the area and remove debris
- D. A neuron cell body reorganizes its Nissl bodies to provide the proteins necessary for axon growth
- E. The Schwann cells form a regeneration tube that helps guide the axon to its proper destination
- F. New fibers will eventually fill the myelin sheath and innervate the muscle. Growth occurs at 3-5 mm/day (1mm = 0.04in)
- G. In the CNS, this repair is unlikely because the neurons lack the neurilemma necessary to form the regeneration tube. Also, the astrocytes quickly fill the damaged area, forming scar tissue. Most CNS injuries cause permanent damage
- H. Crushing and bruising can also damage nerve fibers, resulting in paralysis. Inflammation of the injury site damages more fibers. Early treatment with methyprednisolone reduces inflammation and decreases the severity of the injury. It must be given within 8 hours to be effective

VII. Conduction (“All or None Law”) – when stimulated, a nerve fiber will either respond completely or not at all
- A. Electrical – along the nerve
  1. Resting fiber = polarized = -70mV
     - a. An excess of negative ions on the inside of the membrane and an excess of positive ions on the outside of the membrane
     - b. The electrical difference is called the membrane potential. It is measured in millivolts, so -70 mV indicates that the potential difference has a magnitude

of 70 mV and the inside of the membrane is negative
2. With a stimulus, a “sodium pump” is created – three Na+ move across the membrane and flow into the cell and two K+ diffuse out of the cell; the membrane is now depolarized
3. Myelinated fibers are able to conduct impulses faster because the Na+/K+ exchange can only occur at the node, so impulses leap from node to node
4. Before another electrical current can spread along the nerve fiber, the membrane must repolarize to its original condition. The refractory time is a brief period when a neuron resists restimulation until repolarization is complete
5. The impulse can never move backward

B. Chemical – at the synapse (see the Chemical Synapses Diagram)
1. The impulse arrives at the presynaptic terminal axon
2. This impulse causes Ca++ to enter the axon knob
3. The Ca++ causes synaptic vesicles to migrate to the presynaptic membrane and release hundreds of neurotransmitters into the synaptic cleft
4. The neurotransmitter binds with receptors on the postsynaptic membrane. Function is therefore determined by the post synaptic receptors, not by the neurotransmitter
5. This binding opens channels in the post synaptic membrane, so Na+ moves into the post-cell and K+ moves out – temporary depolarization
6. This causes excitation and the impulse is on its way – conduction has occurred
7. Some neurotransmitters are transported back into the presynaptic knob, where they are repackaged into vesicles and used again

C. Neurotransmitters
1. Acetylcholine (ACh) – the most common, it excites skeletal muscle, but inhibits cardiac muscle; is also involved with memory; a deficiency of ACh could be a cause of Alzheimer’s
2. Amines – synthesized from amino acid molecules
    a. Serotonin – a CNS inhibitor; moods, emotions, and sleep
    b. Histamine – a CNS stimulant; regulation of water balance and temperature, and emotions
    c. Dopamine – has an inhibitory effect on the somatic motor system; without dopamine the body has a general overstimulation of muscles = Parkinsonian tremors; cocaine blocks the uptake of dopamine
    d. Epinephrine – autonomic nervous response, beta receptors, and dilation
    e. Norepinephrine – autonomic nervous response, alpha

receptors, and constriction; antidepressants increase the amount of norepinephrine in brain, relieving depression

3. Amino acids
    a. Glutamate – CNS excitatory
    b. Glycine – CNS inhibitory
4. Neuropeptides – short strands of amino acids called polypeptides
    a. Enkephalins/endorphins – inhibitory; act like opiates to block pain
    b. VIP – vasoactive intestinal peptide
    c. CCK – cholecystokinin
    d. Substance P – excitatory, transmits pain information

VIII. Reflex – a reflex arc is a conduction route to and from the CNS; a regulatory feedback loop (see the Reflex Arc Diagram)

A. Structure
    1. Sensory receptor in the PNS
    2. Sensory afferent neuron
    3. Interneuron(s) in the CNS
    4. Motor efferent neuron
    5. Effector (muscle/gland) tissue in the PNS
B. Types
    1. Deep tendon reflex – patellar tendon, knee jerk
    2. Pupil reflex – to light or dark, constricts or dilates
    3. Corneal reflex – with touch, causes blinking
    4. Gag reflex – to touch, sight, and smell
    5. Plantar reflex – negative Babinski response; toes curl under when the sole is stroked
C. First level reflex
    1. Predictable, fast, automatic
    2. The impulse travels only to the spinal cord
    3. Example – jerking your hand away from a hot stove
D. Second level reflex
    1. Impulse travels to the brain stem
    2. Usually protective
    3. Example – coughing or vomiting
E. Third level reflex
    1. Learned or conditioned reflex
    2. Involves the cerebral cortex
    3. Example – bowel or bladder control
F. Ipsilateral – receptors and effectors are located on one side of the body
G. Contralateral – receptors and effectors are located on opposite sides of the body

IX. Central Nervous System (see the Brain Diagram)
    A. Brain – a mass of 12 billion neurons and neuroglia weighing approximately three pounds, and protected by cranial bones
    B. Cerebrum – largest percentage mass of the brain (83% of brain mass); responsible for higher mental functions and the distribution of impulses (see the Gray and White Matter Diagram)
        1. Cerebral cortex – the outer layer of gray matter; short- and long-term memory
            a. Convolutions – elevated ridges or folds that increase the gray area of brain
            b. Sulci – shallower grooves
            c. Fissures – deep grooves (fetal folds)
                i. Longitudinal – separates the right and left hemispheres; corpus callosum (large fibers that connect the two hemispheres)
                ii. Transverse – separates the cerebrum from the cerebellum
                iii. Fissure of Rolando – divides the frontal and parietal lobes at the coronal suture
                iv. Fissure of Sylvan/lateral fissure – divides the frontal and temporal lobes
        2. Cerebral medulla – white matter, conduction pathways
        3. Divided into right and left hemispheres (the left side governs the right side of the body, the right side governs the left side of the body)
        4. Lobes
            a. Frontal – voluntary motor control, learning, planning, and speech
            b. Parietal – sensory, distance, size, shape, and cognitive/intellectual processes
            c. Occipital – vision and visual memory
            d. Temporal – auditory, olfactory, speech, judgment, reasoning, and willpower
    C. Cerebellum – below and posterior to the cerebrum
        1. The right and left hemispheres are connected by the central vermis
        2. Outer gray, inner white forms the arbor vitae
        3. Coordinates muscular movement, posture, balance, running, and walking
        4. Damage produces ataxia (a lack of coordination due to errors in speed, force, and direction of movement)
    D. Brainstem (damage = coma) (see the Pons and Midbrain Diagram)
        1. Midbrain – the upper part of the brainstem
            a. Controls postural reflexes and walking
            b. Visual reflexes and auditory control, 3-4 cranial nerves

2. Pons – a two-way conduction pathway; mixed gray and white fibers
    a. Controls inspiration
    b. Transverse fibers give it a bridge appearance
    c. Reflex mediation for 5-8 cranial nerves
3. Medulla oblongata – the bulb (the lowest part before the foramen magnum); made of white and gray fibers called the reticular formation
    a. 75% of nerve fibers cross here
    b. Controls vital functions – respiration and circulation
    c. Pyramids – bulges of white tracts on the ventral surface

E. Diencephalon – the area between the cerebrum and the midbrain
1. Thalamus – gray matter, the relay station for sensory incoming and motor outgoing impulses; damage = increased sensitivity to pain and loss of consciousness
2. Hypothalamus – forms the floor of the third ventricle
    a. Regulates autonomic control
    b. Cardiovascular control – dilates and constricts
    c. Temperature control
    d. Controls appetite – hunger and thirst
    e. Water balance
    f. GI control – peristalsis, intestinal secretions
    g. Emotional states – fear, anger, pleasure, pain, and sexual reflexes
    h. Sleep control
    i. Regulates pituitary secretions
    j. CHO and fat metabolism
3. Epithalamus – contains the pineal body/gland (melatonin)

F. Meninges – three membranous coverings with spaces between each
1. Dura mater – “tough mother”; strong, white, fibrous tissue that lines the skull bones; has inward extensions into the fissures
    a. Epidural space – between the bone and the dura mater
    b. Subdural space – between the dura and arachnoid layers
2. Arachnoid – resembles fine cobwebs with fluid (CSF) filling the spaces
    a. Subarachnoid space – between the arachnoid and pia layers
3. Pia mater – “tender mother”; covers the brain and spinal cord surface

G. Cerebrospinal Fluid (CSF) – bathes the skull, brain, and spinal cord (see the Spinal Cord Protective Covering Diagram)
1. Serves as a shock absorber for the brain and spinal cord
2. 400-500 ml produced daily, yet only 140 ml is circulating at

any time
3. Circulates through the ventricles and into the central canal and subarachnoid spaces, and is absorbed back into the blood
4. Provides nutrients and waste removal for brain tissues
5. It is clear, colorless, and composed of water, 40-60% glucose, NaCl, K+, protein, and a few white blood cells

H. Ventricles – CSF-filled spaces of the brain; the rich network of blood vessels, the choroid plexus, maintains selective permeability to protect brain tissue
1. Foramen of Monro – connects the lateral ventricles to the third ventricle (behind and below the laterals)
2. Aqueduct of Sylvus – connects the third and fourth ventricle
3. In the roof of the fourth ventricle are openings, the foramen of Magendie and foramen of Luschka, that allow the CSF to move into the cisterna magna, a space behind the medulla that is continuous with the subarachnoid space

I. Spinal cord
1. Deep grooves – anterior median fissure (deeper) and posterior median sulcus
2. Two bundles of nerve fibers, called roots, project from each side of the cord
   a. Dorsal nerve root – sensory afferent fibers
   b. Dorsal root ganglion – sensory cell bodies
   c. Ventral nerve root – motor efferent fibers
   d. The nerve roots join together to form a single, mixed nerve called a spinal nerve
3. "H"
   a. The gray matter of cell bodies of interneurons and motor neurons, divided into anterior, posterior, and lateral horns
   b. White matter surrounds gray "H"; divided into anterior, posterior, and lateral columns (large bundles of nerve axons divided into smaller bundles called tracts); ascending and descending, and lateral organizational tracts
   c. Transcutaneous electrical nerve stimulation unit (TENS) – acts to close the gates of the ascending tracts; therefore pain impulses are not allowed to get to the brain
   d. Lumbar puncture – a spinal tap between the 3rd and 4th lumbar vertebrae for CSF diagnostics

X. Peripheral Nervous System

A. Cranial Nerves – twelve pairs: "On Old Olympus' Towering Top, A Finn, and German Grew Some Hops", "Some Say Marry Money

But My Brother Says, Bad Business, Marry Money"

1. Olfactory – I: sensory, smell
2. Optic – II: sensory, vision
3. Oculomotor – III: motor, eye movement and pupil
4. Trochlear – IV: motor, eye movement, peripheral vision
5. Trigeminal – V: both, ophthalmic maxillary, mandibular (sensory); face and head (motor)
6. Abducens – VI: motor, abducts eye
7. Facial Nerve – VII: both, facial expression, taste, tongue movement
8. Vestibulocochlear – VIII: sensory, hearing and balance
9. Glossopharyngeal – IX: both, tongue, throat, swallowing
10. Vagus – X: both, organ sense (thoracic and abdominal) inhibitor
11. Accessory – XI: motor, spinal accessory, shoulder and head movement
12. Hypoglossal – XII: motor, tongue and throat movement

B. Spinal Nerves – 31 pairs of mixed nerves attached to the spinal cord via ventral and dorsal roots
   1. Eight cervical (pass through intervertebral foramina), twelve thoracic, five lumbar (exit the cord at the 1st lumbar vertebra, but do not exit the spinal canal until reaching their intervertebral foramina; this gives the cord a "cauda equina" look), five sacral, one coccygeal
   2. Each nerve splits into several large branches + rami, which subdivide into four complex networks called plexuses (cervical, brachial, lumbar, sacral)
   3. Dermatome is an area of skin that is mainly supplied by a single spinal nerve

XI. Special Senses

A. Sense of taste
   1. Chemoreceptors respond to chemicals in an aqueous solution
   2. Taste – gustation
   3. Taste buds – sensory receptor organs for taste; primarily on the tongue papillae
   4. Primary sensations: sweet, salty, sour, bitter
   5. Sensitivity
      a. Tip of the tongue – sweet and salty
      b. Sides of the tongue – sour
      c. Back of the tongue – bitter
   6. Thresholds
      a. Bitter – minute amounts
      b. Sour – less sensitive
      c. Sweet and salty – least sensitive

7. Anterior 2/3 of tongue sensory stimulation travels via the facial nerve to the parietal lobe of the cerebral cortex for interpretation and appreciation of what is being tasted
8. Posterior 1/3 of tongue sensory stimulation travels via the glossopharyngeal nerve to the medulla oblongata and then to the parietal lobe of the cerebral cortex for interpretation
9. 80% of taste is actually smell
10. Other influences – thermoreceptors, mechanoreceptors, nocioreceptors (temperature and texture enhance or distract from taste, i.e. chili peppers stimulate the pain receptors)

B. Sense of smell
   1. Specialized neurons with olfactory cilia in the upper nasal cavity
   2. Stimulated by gas molecules or chemicals
   3. Sniffing draws air forcefully up into the nose
   4. Sensory cells live for an average of 30 day
   5. Sensory cells are affected by a variety of factors – age, nutrition, hormones, drugs, and therapeutic radiation
   6. When stimulated, send impulses via the olfactory nerve to the cerebral cortex for interpretation
   7. Smell memory is long-lasting and stimulation by similar smells can trigger memories of events that occurred long ago
   8. Olfactory receptors are easily fatigued – adaptation occurs
      a. The process of conforming to the environment after continuous stimulation of a constant intensity
      b. These changes in awareness of odors allow us to continue to function at an optimum level
   9. Seven primary odors – floral, musky, camphorous, pepperminty, ethereal, pungent (stinging), putrid (rotten)
   10. Homeostatic imbalances
      a. Anosmias – without smell; some genetic causes, head injuries that tear the olfactory nerves, aftereffects of nasal cavity inflammation (cold, allergy, smoking), physical destruction of the nasal cavity due to polyps, aging, zinc deficiency
      b. Uncinate fits – olfactory hallucinations, epileptic auras (transient uncinate fits)

C. Sense of vision (see the Eye Diagram)
   1. Anatomy
      a. Eyebrows – physical protection of the eyes; short, coarse hairs
      b. Eyelids (palpebrae) – physically protect the eye and prevent the cornea from drying via the blink reflex; medial and lateral canthi (angle of eye); caruncle (fleshy elevation of the medial canthus which contains

sebaceous and sweat glands to produce “Sandman’s eye-sand”)

c. Eyelashes – hairs with glands at the base for lubrication; inflammation = a sty
d. Meibomian glands – secrete a lipid tear film spread by blinking; reduces evaporation of the tear film, prevents the tear film from running down the face; gives an even spread over the eyeball; inflammation = chalazion
e. Lacrimal glands – secrete an aqueous tear film containing globulins and lysozyme; supplies nourishment to the cornea and helps to provide antimicrobial activity; nasolacrimal duct (empties into the nasal cavity; excess tears = tearing, nasal secretions; secretions decrease with age)
f. Conjunctiva – the membrane that lines the eyelid; secretes a mucous tear component that helps reduce surface tension; it accumulates at the medial canthus (corner angle) as “sleep”; inflammation = pinkeye
g. Extrinsic eye muscles – annular ring (tendinous ring from which originate the rectus muscles); rectus muscles (superior, inferior, lateral, and medial each moves the eye in direction of its name); oblique muscles (superior, inferior each moves the eye in the vertical plane when the eye is turned medially by the rectus muscle); diplopia = double vision when movements are not perfectly coordinated, and inability to focus both eyes; strabismus = congenital weakness causing a cross-eyed appearance (the deviant eye becomes functionally blind)
h. Sclera – the outermost white covering of the eyeball; anchor site for muscles
i. Cornea – the transparent front of the sclera; it has no blood vessels but is richly supplied with sensory nerves; depends on tear film for nutrition, O_2, and removal of waste; a window for light to enter; extraordinary capacity for regeneration; transplantation without rejection due to avascular nature
j. Choroid – the highly vascular middle layer of eye; dark membrane on the posterior wall inside the eye; provides nutrients to all tunics; pigment absorbs light to prevent scatter and reflection internally
k. Ciliary body – encircles the lens
l. Anterior chamber – between the cornea and the iris; filled with an aqueous humor that supplies nutrients to the cornea; helps maintain the ocular shape; constantly being formed; excess drains through the canal of

Schlemm to the bloodstream; the amount regulates intraocular pressure; increased pressure = glaucoma, which results in atrophy of the optic nerve and blindness

m. Iris – the visible, colored part of the eye; muscles control pupil size which regulates the amount of light entering the lens; sympathetic = dilation, parasympathetic = constriction
n. Pupil – the round central opening of the iris; allows light to enter
o. Lens – a transparent spherical structure suspended by suspensory ligaments between the iris and the vitreous humor; being a convex lens – 1/3 of the refractive power of the eye; accommodation = as objects are brought closer to the eye, the ciliary muscles contract and make the lens more convex, increasing its refractive power; (presbyopia = during the aging process, the lens loses elasticity; diabetes – excess glucose draws water into the lens causing opacity changes = cataracts)
p. Vitreous humor – secreted by the retinal cells; makes up the posterior chamber; maintains the shape of the eye, positions the retina against the choroid, and transmits light
q. Retina – the innermost pigment layer of the eye where the rods and cones (visual receptors) are located; absorbs light and recycles visual pigments; visual pigments, rhodopsin (in rods – dim light, peripheral vision) and Iodopsin (in cones – bright light, high acuity, color vision), are converted into opsin and reinene (vitamin A derivative) which stimulate the bipolar neurons (converge to form optic nerve); diabetic retinopathy = small, retinal hemorrhages occur due to excess glucose in the blood – disrupts O_2 to the rods and cones – blindness; nyctalopia = deficiency of vitamin A – night blindness
r. Fovea – the focus point for light rays for the best visual acuity; composed mostly of cone cells
s. Optic disc – the “blind spot” where neurons exit the eyeball as the optic nerve

2. Sense of sight
   a. Light waves are bent first by the cornea, the eye’s fixed outer lens; bending of the light rays = refraction; the iris, whose pigment gives an eye its color, contracts in bright light and expands in dim light to regulate the amount of light entering the pupil; ciliary muscles

around the inner crystalline lens flex to focus the image precisely on the retina, a thin sheet of nerve tissue

b. Light floods the retina and activates the photoreceptors, called rods and cones (due to their shape); cones specialize in bright light and are concentrated in a central patch of the retina called the fovea; cones provide acute central vision, rich with color; the colorblind rods enable us to see in dim light; signals from the rods and cones are sent to the cerebral cortex via the optic nerve; as much as 1/3 of the cortex is devoted to visual processing; sight mediates and validates the other senses
c. At the optic chiasm, the nerve splits, distributing input from each eye to relay stations in the thalamus; this circuitry enables us to see with one eye if necessary; different neurons transmit data about motion, color, fine detail, and depth perception
d. The visual area of the temporal cortex identifies and recognizes the object; an area of the parietal cortex locates the object in relation to space
e. Visual acuity – the clearness or sharpness of visual perception recorded as two numbers
    i. The first number represents the distance in feet between the subject and the test chart (Snellen Chart)
    ii. The second number represents the number of feet away that a person with normal acuity would stand to see clearly
    iii. 20-20 is considered normal acuity
    iv. 20-100 means a person can see objects at 20 feet that a person with normal vision can see at 100 feet
    v. Visual acuity worse than 20-200 after correction is considered legally blind
f. Homeostatic imbalances
    i. Myopia – nearsighted; focus falls short of the retina; far objects are blurred; radial keratotomy can correct or improve this condition
    ii. Hyperopia – farsightedness; focus falls behind the retina; close objects are blurred
    iii. Astigmatism – the cornea is not spherical; the focused image is distorted
    iv. Color blindness – a congenital lack of one or more types of cones (red, green, blue); sex-linked

D. Sense of hearing (see the Ear Diagram)
    1. Anatomy of the external ear

a. Auricle (pinna) – the flap that funnels sound waves; helix = rim; lobule = earlobe
b. External auditory meatus – the opening to the auditory canal, lined with cerumen/wax glands
c. External auditory canal – a short, narrow chamber extends from the auricle to the tympanic membrane
d. Tympanic membrane – the eardrum, that stretches across the canal and vibrates in response to sound waves; transmits them to the middle ear

2. Anatomy of the middle ear – tiny cavity in the temporal bone
   a. Auditory ossicles – three bones that vibrate to transmit sound waves to the inner ear
      i. Malleus – a hammer-shaped, handle is attached to the tympanic membrane
      ii. Incus – anvil-shaped
      iii. Stapes – stirrup-shaped
   b. Oval/vestibular window – opens to the internal ear
   c. Round/Cochlear window – covered by a membrane; opens to the internal ear
   d. Pharyngotympanic/auditory/Eustachian tube – connects the middle ear to the pharynx; helps to equalize pressure so the eardrum will vibrate; children's tubes are more horizontal – otitis media (myringotomy = lancing of the eardrum to relieve pressure – insertion of tubes for drainage of fluid/pus)
   e. Mastoid sinuses – air spaces in the temporal bone that drain into the middle ear
3. Anatomy of the inner ear – labyrinth, located in the hollowed out portion of the temporal bone
   a. Vestibule and semicircular canals – involved in equilibrium; maculae found in the utricle and sacule of the vestibule provide information related to head position; crista ampullaris in the semicircular canals respond to angular/rotational movements of the head; tiny otoliths detect changes due to position and stimulate a reflex to restore normal body position
   b. Cochlea – the snail-like part of the inner ear for hearing; surrounded by perilymph and filled with endolymph fluid
      i. The upper section is the scala vestibuli
      ii. The lower section is the scala tympani
      iii. Reissner's membrane = the floor of the cochlea
      iv. Basilar membrane = the floor of the cochlea
      v. Organ of Corti – the receptor organ for hearing – the eighth cranial nerve; the sense organ that rests on the basilar membrane, consisting of hair cells; sensory dendrites are wrapped around the

base of the hair cells; they transmit impulses to the axons that form the auditory (acoustic) nerve

4. The physiology of hearing
    a. Sound waves are caught by the auricle, channeled through the auditory canal, and strike against the tympanic membrane causing it to vibrate
    b. Vibrations move the malleus, incus, and stapes against the oval window
    c. Pressure is exerted inward into the perilymph of the scala vestibuli
    d. A ripple starts in the perilymph that is transmitted through the vestibular membrane to the endolymph inside the organ of Corti
    e. The endolymph ripple causes the basilar membrane to bulge up in response to sound wave vibrations; the higher the upward bulge, the more cilia are bent, the more cells are stimulated on the basilar membrane
    f. The stimulated cells transmit nerve impulses along the auditory nerve
    g. Impulses travel to the auditory cerebral cortex – are interpreted as sound
    h. Sound volume is determined by the height (amplitude) of the waves; sound pitch is determined by the frequency of the waves; the decibel unit is used for measuring the volume of sound

Decibel Level	Example of Noise	Dangerous Time
0	Lowest audible sound	
30	Quiet library	
50	Refrigerator noise	
70	Noisy restaurant	Critical level
80	Factory noise	8 + hours
90	Shop tools	Impairment
100	Chain saws	< 2 hours
120	Rock concert	Immediate harm
140	Gunshot blast	Damage probable
180	Rocket launchpad	Permanent loss

5. Homeostatic imbalances

a. Conduction deafness – something interferes with the conduction of sound vibrations to the fluids of the inner ear, i.e. impacted earwax, perforated/ruptured eardrum, otitis media, otosclerosis of ossicles
b. Sensorineural deafness – damage to the neural structures at any point, from the cochlear hair cells to the auditory cortical cells; can be the gradual loss of receptor cells, exposure to a single loud noise, degeneration of the cochlear nerve, cerebral infarcts, or tumors; treatment can be cochlear implants
c. Tinnitus – a ringing or clicking sound in the ears in the absence of auditory stimuli; can be the first symptom of cochlear nerve degeneration, inflammation of the middle/inner ear, or the side effect of some medications, i.e. aspirin
d. Meniere's Syndrome – a labryrinth disorder that affects the semicircular canals and cochlea; transient but repeated attacks of severe vertigo
e. Presbycusis – loss of the ability to hear high-pitched sounds; becoming common in young people due to noise

E. Sense of touch, heat, cold, and pain
1. Sensory receptors make it possible for the body to respond to environmental stimuli
2. Receptors respond to a stimulus and convert the stimulus to a nerve impulse
3. Nerve impulses travel via afferent sensory neurons to the brain for interpretation
4. Touch – mechanoreceptors/exteroceptors; located on the body surfaces; respond to touch, stretch, and pressure
a. Meissner's corpuscles – in the fingertips, lips, and hairless body parts for fine touch
b. Pacinian corpuscles – in the skin, joints, and genitals for deep pressure and stretch
c. Krause's end bulbs – in the eyelids, lips, and genitals for light touch
d. Ruffini's corpuscles – found in the skin for continuous touch
5. Heat/cold – thermoreceptors
6. Pain – nocioceptors; free nerve endings for pain, tickling, itching; noci = pain, injury

XII. Disorders of the Nervous System
A. Shingles – herpes zoster viral infection; causes inflammatory vesicles along the peripheral nerves
B. Neuralgia – a sudden, sharp severe stabbing pain along a nerve

pathway

C. Neuritis – inflammation of a nerve; causes pain, muscular atrophy, hypersensitivity, and paresthesia
D. Tic douloureux – degeneration of the trigeminal nerves; causes repeated, involuntary muscle twitching
E. Bell's palsy – unilateral facial paralysis, sudden onset, viral inflammation of the trigeminal nerve
F. Poliomyelitis – (polio) is a highly infectious viral disease, which mainly affects young children. The virus is transmitted through contaminated food and water, and multiplies in the intestine, from where it can invade the nervous system; permanent paralysis or weakness
G. Encephalitis – a viral inflammation of brain tissue; causes fever, lethargy, weakness, nuchal rigidity and opisthotonos, coma, and death
H. Meningitis – a bacterial or viral inflammation of the meninges; causes headache, fever, sore throat, back and neck pain, and loss of mental alertness
I. Meningiocele – a congenital hernia in which the meninges protrude through an opening in the spinal cord
J. Epilepsy – idiopathic recurring and excessive electrical discharge from neurons causing seizure activity (grand mal, petit mal)
K. Hydrocephalus – an increased accumulation of CSF within the ventricles; causes the cranium to enlarge unless treated with a shunt to remove excess fluid
L. Parkinson's disease – tremors, uncontrolled shaking; related to decreased amounts of dopamine
M. Huntington's chorea – a progressive dementia with bizarre involuntary movements; genetic
N. Athetosis – slow, irregular, twisting, snakelike movements of the hands
O. Hemiballism – jerking and twitching movements of one side of the body; caused by a tumor of the thalamus
P. Dysmetria – an inability to fix the range of movement in muscle activity
Q. Cerebral palsy – a congenital brain disorder/damage causing damage to motor neurons; flaccid or spastic paralysis
R. Multiple sclerosis – autoimmunity destruction of oligodendrocytes leading to demyelination with progressive muscular weakness
S. Muscular dystrophy – a genetic defect in muscle metabolism; causes progressive atrophy
T. Myasthenia gravis – a disease characterized by muscular weakness, possibly due to decreased amounts of acetylcholine at the muscle effector sites
U. Alzheimer's disease – dementia-producing lesions in the cerebral cortex

V. Anencephalic – infants born without a frontal cerebrum; congenital, possibly related to toxins, may be related to a folic acid deficiency in the mother

Activity

I. Make flash cards of neurological terms and practice putting the terms together with prefixes and suffixes to make new terms.
II. Complete the Nervous System Worksheet.
III. Complete the Nervous System Medical Terminology Worksheet.
IV. Review media terms with the students using review games such as the "Fly Swatter Game" or the "Flash Card Drill" (see the Medical Terminology Activity Lesson Plan - http://texashste.com/documents/curriculum/principles/medical_terminology_activities.pdf)
V. Research and report on diseases and disorders of the nervous system.

Assessment

Successful completion of activities

Materials

Nervous System worksheet
Medical term worksheet

Accommodations for Learning Differences

For reinforcement, the student will practice terms using flash cards of the nervous system.

For enrichment, the student will choose a disease related to the nervous system and research the disease using the internet. Students will share their findings with the class.

National and State Education Standards

HLC02.01 Health care workers will know the various methods of giving and obtaining information. They will communicate effectively, both orally and in writing.

TEKS
202.1C Student is expected to interpret technical material related to the health science industry.
202.1D Student is expected to organize, compile, and write ideas into reports and summaries.
202.1E Student is expected to plan and prepare effective oral presentations.
202.1F Student is expected to formulate responses using precise language

to communicate ideas.
202.2B Student is expected to demonstrate effective communication skills for responding to the needs of individuals in a diverse society.
202.2D Student is expected to accurately interpret, transcribe, and communicate medical vocabulary using appropriate technology

College and Career Readiness Standards
English/language art
B.1 Identify new words and concepts acquired through study of their relationships to other words and concepts.
B2. Apply knowledge of roots and affixes to infer the meanings of new words.
B3. Use reference guides to confirm the meanings of new words or concepts.
Cross- Disciplinary standards-Foundational Skills
A2. Use a variety of strategies to understand the meanings of new words

Nervous System Worksheet

1. What are the major functions of the nervous system?

2. Describe the organs of the central nervous system and their functions.

3. Describe the parts of the peripheral nervous system and their functions.

4. What cell forms the “White Matter”?

5. What cell forms the myelin sheaths around the axons of the PNS?

6. Explain the difference between the sensory afferent pathway and the motor efferent pathway.

7. Differentiate between white and gray matter.

8. Describe the meninges:
   a. dura mater
   b. arachnoid mater
   c. pia mater
9. Identify and briefly describe the four principle parts of the brain.
   a. cerebrum
   b. cerebellum
   c. brain stem
   d. diencephalon

10. Describe CSF and identify the areas where it is typically found.
    a. CSF is

    b. Where is CSF located?

11. List the twelve cranial nerves and their main functions.
    a.

    b.

    c.

    d.

    e.

    f.

    g.

    h.

    i.

    j.

    k.

    l.

12. Describe the following disorders:
    a. Shingles –

    b. Neuralgia –

    c. Neuritis –

    d. Tic Douloureux –

    e. Bell's Palsy –

    f. Poliomyelitis –

    g. Encephalitis –

    h. Meningitis –

i. Meningiocele –

j. Epilepsy –

k. Hydrocephalus –

l. Parkinson’s Disease –

m. Huntington’s Chorea –

n. Athetosis –

o. Hemiballism –

p. Dysmetria –

q. Cerebral Palsy –

r. Multiple Sclerosis –

s. Muscular Dystrophy –

t. Myasthenia Gravis –

u. Alzheimer’s Disease –

v. Anencephalic –

Nervous System Worksheet – **Key**

1. What are the major functions of the nervous system?
    i. Monitors change (stimuli) – sensory input
    ii. Integrates impulses – integration
    iii. Affects responses – motor output

2. Describe the organs of the central nervous system and their functions.
    i. Brain and spinal cord
    ii. Integrates incoming pieces of sensory information, evaluates the information, and initiates the outgoing responses

3. Describe the parts of the peripheral nervous system and their functions.
    i. Made of 12 pairs of cranial nerves and 31 pairs of spinal nerves
    ii. Afferent (sensory) division
        1. Carries impulses toward the CNS
        2. Somatic (skin, skeletal muscles, joints)
        3. Visceral (organs within the ventral cavity)
    iii. Efferent (motor) division
        1. Somatic – carries information to the skeletal muscles (reflex and voluntary control)
        2. Autonomic – involuntary; regulates smooth muscles, cardiac muscle, and glands
            a. Sympathetic – exit the thoracic area of the spinal cord and involved in preparing the body for “fight or flight”
            b. Parasympathetic – exit the cervical and lumbar areas of the spinal cord; coordinates the body’s normal resting activities (“resting and digesting-repairing”)

4. What cell forms the “White Matter”?
   Oligodendrocytes

5. What cell forms the myelin sheaths around the axons of the PNS?
   Schwann cells

6. Explain the difference between the sensory/afferent pathway and the motor/efferent pathway.
    i. The Sensory/Afferent – the dendrites are connected to receptors where stimulus is initiated in the skin/organs, and carry impulses toward the CNS; axons are connected to other neuron dendrites; unipolar except for the bipolar neurons in special sense organs; cell bodies in the sensory ganglia outside the CNS
        1. Receptors – extroceptors (pain, temperature, touch); interoceptors (organ sensation); proprioceptors (muscle sense, position, movement)

ii. The Motor/Efferent – carry messages from the CNS to effectors; the dendrites are stimulated by other neurons and the axons are connected to effectors (muscles and glands); multipolar except for some in the ANS

7. Differentiate between white and gray matter.
    i. Regions of the CNS which contain myelinated axons are referred to as white matter, and Regions of the CNS which contain mostly nerve cell bodies and unmyelinated axons are referred to as gray matter

8. Describe the meninges:
    a. dura mater – the outer layer. The dura mater, or "tough mother," is a double-layered membrane. One layer is attached to the inner surface of the skull while the other layer forms the outer meningeal layer
    b. arachnoid mater – the middle layer. The arachnoid mater, or "spider mother," has threadlike extensions to span the subarachnoid space and attach it to the innermost membrane (the subarachnoid space is filled with cerebrospinal fluid)
    c. pia mater – the most inner layer. The pia mater, or "soft mother," clings tightly to the surface of the brain and spinal cord

9. Identify and briefly describe the four principle parts of the brain.
    a. cerebrum – the largest part of the brain; divided into paired halves known as the cerebral hemispheres. They are connected by a band known as the corpus callosum. The cerebrum is divided into four lobes: frontal, parietal, temporal and occipital. Conscious thought processes, memory storage and retrieval, sensations, and complex motor patterns originate here
    b. cerebellum – a large, cauliflower-like structure found inferior to the occipital lobe of the cerebrum. It has two hemispheres and contains both white and gray matter. The cerebellum provides the precise timing for coordinating skeletal muscle activity and controls balance and equilibrium. It also stores memories of previous movements
    c. brain stem – about the size of a thumb in diameter and approximately three inches long. It is the most inferior brain structure. Its sections include the medulla oblongata, the pons, and the midbrain
    d. diencephalons – superior to the brainstem and surrounded by the cerebral hemispheres. The major structures of the diecephalon include the thalamus and the hypothalamus. The thalamus functions as a relay station for sensory impulses, except for smell. As the impulses pass, we have a basic recognition of whether the sensation will be pleasant or unpleasant. The hypothalamus regulates body temperature, water balance, and metabolism. It is also important in regulating thirst, hunger, blood pressure, pleasure, and the sex drive

10. Describe CSF and identify the areas where it is typically found.

a. CSF is a clear, watery fluid similar to blood plasma. It is continuously formed from the blood by the choroid plexus
b. Where is CSF located? CSF is found circulating in the ventricles of the brain and in the subarachnoid space surrounding the brain and spinal cord

11. List the twelve cranial nerves and their main functions.
    a. Olfactory – sensory, smell
    b. Optic – sensory, vision
    c. Oculomotor – motor, eye movement and pupil
    d. Trochlear – motor, eye movement, peripheral vision
    e. Trigeminal – both, ophthalmic maxillary, mandibular (sensory); face and head (motor)
    f. Abducens – motor, abducts the eye
    g. Facial Nerve – both, facial expression, taste, tongue movement
    h. Vestibulocochlear – sensory, hearing and balance
    i. Glossopharyngeal – both, tongue, throat, swallowing
    j. Vagus – both, organ sense (thoracic and abdominal) inhibitor
    k. Accessory – motor, spinal accessory, shoulder and head movement
    l. Hypoglossal – motor, tongue and throat movement

12. Describe the following disorders:
    a. Shingles – herpes zoster viral infection, causes inflammatory vesicles along the peripheral nerves
    b. Neuralgia – sudden, sharp severe stabbing pain along a nerve pathway
    c. Neuritis – inflammation of a nerve; causes pain, muscular atrophy, hypersensitivity, and paresthesia
    d. Tic Douloureux – degeneration of trigeminal nerves causes repeated, involuntary muscle twitching
    e. Bell's Palsy – unilateral facial paralysis, sudden onset, viral inflammation of the trigeminal nerve
    f. Poliomyelitis – a viral infection of gray matter of the spinal cord causing permanent paralysis or weakness
    g. Encephalitis – a viral inflammation of the brain tissue; causes fever, lethargy, weakness, nuchal rigidity and opisthotonos, coma, and death
    h. Meningitis – bacterial or viral inflammation of the meninges; causes headache, fever, sore throat, back and neck pain, loss of mental alertness
    i. Meningiocele – a congenital hernia in which the meninges protrudes through an opening in the spinal cord
    j. Epilepsy – idiopathic recurring and excessive electrical discharge from neurons causing seizure activity (grand mal, petit mal)
    k. Hydrocephalus – an increased accumulation of CSF within the ventricles; causes the cranium to enlarge unless treated with a shunt to remove excess fluid
    l. Parkinson's Disease – tremors, uncontrolled shaking, related to decreased amounts of dopamine
    m. Huntington's Chorea – progressive dementia with bizarre involuntary movements; genetic
    n. Athetosis – slow, irregular, twisting, snakelike movements of the hands
    o. Hemiballism – jerking and twitching movements of one side of the body; caused by a tumor of the thalamus
    p. Dysmetria – the inability to fix the range of movement in muscle activity

q. Cerebral Palsy – a congenital brain disorder/damage causing damage to the motor neurons; flaccid or spastic paralysis
r. Multiple Sclerosis – autoimmunity destruction of the oligodendrocytes leading to demyelination with progressive muscular weakness
s. Muscular Dystrophy – a genetic defect in muscle metabolism; causes progressive atrophy
t. Myasthenia Gravis – a disease characterized by muscular weakness, possibly due to decreased amounts of acetylcholine at the muscle effector sites
u. Alzheimer's Disease – a dementia producing lesions in the cerebral cortex
v. Anencephalic – infants born without a frontal cerebrum; congenital; possibly related to toxins, may be related to folic acid deficiency in the mother

Nervous System Medical Terminology Worksheet

Please write the meaning of the terms in the right column.

Prefixes, Suffixes, and Root Words:

af	
-al	
-algia	
ambul	
an	
astr/o	
cephal/o	
cerebell/o	
cerebr/o	
crani/o	
-cyte	
dendr/o	
-drome	
dur/o	
-eal	
ef	
encephal/o	
epi	
esthesi/o	
-ferent	
gangli/o	
-glia	
gloss/o	
-graphy	
hemi-	
home/o	
hydr/o	
hypo	
-ia	
-iatry	
-ic	
-ictal	
intra	
-ism	
-itis	

kino	
-lepsy	
-logy	
-mania	
megal/o	
mening/o	
ment/o	
micr/o	
mon/o	
mot/o	
myel/o	
neur/o	
ocul/o	
olfact	
olig/o	
-ologist	
-ology	
opt/o	
-otomy	
para	
-paresis	
-pathy	
phag/o	
pharyng/o	
phas/o	
phren/o	
-plegia	
poli/o	
poly	
pre-	
psych/o	
quad	
radicul/o	
rhiz/o	
spina	
-stasis	
syn	
tetra-	
-tomy	

tri	

Medical Terms

afferent	
anesthesia	
astrocyte	
cerebrospinal	
craniotomy	
dementia	
dendrites	
dysphagia	
dysphasia	
efferent	
encephalitis	
encephalotomy	
epilepsy	
glossopharyngeal	
hemiparesis	
hemiplegia	
homeostasis	
hydrocephalus	
hypoglossal	
intracranial	
kinesthetic	
megalomania	
meninges	
meningitis	
meningocele	
microencephaly	
microglia	
motor	
myelography	
narcolepsy	
neuralgia	
neuroglia	
neuroglial	
neurology	
oculomotor	
olfactory	

oligodendrocyte	
optic	
paralysis	
paraplegia	
poliomyelitis	
polyneuritis	
quadriplegia	
radiculopathy	
schizophrenia	
somatic	
somnambulism	
spinal	
syndrome	

Medical Abbreviations

amt	
ASA	
ASAP	
bid	
cc	
cm	
dc	
dr	
CNS	
CSF	
g	
gm	
gr	
gtt	
h	
HA	
hs	
IM	
IV	
kg	
lb	
LOC	
mg	
mgm	

ml	
NKA	
NKDA	
noct	
OTC	
oz	
PDR	
PK	
PM	
po	
PRN	
q	
qam	
qd	
qday	
q3h	
qid	
R	
Rx	
sig	
tab(s)	
tbsp	
tid	
tsp	
Tx	

KEY - Nervous System Medical Terminology Worksheet

Prefixes, Suffixes, and Root Words:

af	to, toward
-al	pertaining to
-algia	pain
ambul	ambulate (walking)
an	without, absence of
astr/o	star
cephal/o	head, brain
cerebell/o	cerebellum
cerebr/o	cerebrum
crani/o	cranium, skull, helmet
-cyte	cell
dendr/o	branches
-drome	symptoms running with
dur/o	dura mater
-eal	pertaining to
ef	away from
encephal/o	brain
epi	on, upon
esthesi/o	feeling or sensation
-ferent	carry
gangli/o	ganglion
-glia	glue
gloss/o	tongue
-graphy	the process of making a picture
hemi-	half
home/o	same
hydr/o	water
hypo	less than
-ia	state of
-iatry	treatment, cure
-ic	pertaining to
-ictal	seizure, attack
intra	within
-ism	condition or state of
-itis	inflammation of
kino	movement
-lepsy	seizure

-logy	study of
-mania	madness
megal/o	large
mening/o	meninges
ment/o	mind
micr/o	small
mon/o	one
mot/o	motor, to move
myel/o	spinal cord
neur/o	nerve, neuron
ocul/o	eye
olfact	smell
olig/o	few
-ologist	one who studies
-ology	study of
opt/o	eye
-otomy	to cut into
para	beside, beyond, around
-paresis	slight paralysis
-pathy	disease
phag/o	eating, swallowing
pharyng/o	throat
phas/o	speech
phren/o	diaphragm
-plegia	paralysis
poli/o	gray matter
poly	many
pre-	before
psych/o	mind
quad	four
radicul/o	nerve root
rhiz/o	nerve root
spina	spine
-stasis	standing still
syn	with, together
tetra-	four
-tomy	to cut into
tri	three

Medical Terms

afferent	to carry towards
anesthesia	without feeling or sensation
astrocyte	star (shaped) cell
cerebrospinal	pertaining to the brain (cerebrum) and spinal cord
craniotomy	to cut into the skull
dementia	to lose one's mind
dendrites	branches
dysphagia	difficulty swallowing
dysphasia	difficulty speaking
efferent	to carry away from
encephalitis	inflammation of the brain
encephalotomy	to cut into the brain
epilepsy	upon (recurrent) seizures
glossopharyngeal	pertaining to the tongue and throat
hemiparesis	half (of the body) slightly paralyzed
hemiplegia	half (of the body) paralyzed
homeostasis	condition of standing still (staying the same)
hydrocephalus	water in the brain
hypoglossal	below the tongue
intracranial	within the skull
kinesthetic	pertaining to movement
megalomania	madness about great or large (having an overinflated ego)
meninges	meninges or coverings of the brain
meningitis	inflammation of the brain coverings (inflammation of the meninges).
meningocele	herniation or protrusion of the meninges
microencephaly	abnormally small head
microglia	small glue
motor	referring to movement
myelography	the process of recording a picture of the spinal cord
narcolepsy	sleep seizures
neuralgia	nerve pain
neuroglia	nerve glue
neuroglial	pertaining to nerve glue
neurology	the study of nerves
oculomotor	movement of the eye
olfactory	referring to smell
oligodendrocyte	specialized nerve cell
optic	pertaining to the eye

paralysis	unable to move
paraplegia	unable to move lower extremities (paralysis)
poliomyelitis	inflammation of the gray matter of the spinal cord
polyneuritis	inflammation of many nerves
quadriplegia	paralysis of four extremities
radiculopathy	nerve root disease
schizophrenia	condition of split mind
somatic	referring to the body
somnambulism	state of sleepwalking
spinal	pertaining to the spine or pertaining to the spinal cord
syndrome	symptoms that run together

Medical Abbreviations

amt	amount
ASA	aspirin
ASAP	as soon as possible
bid	twice a day
cc	cubic centimeter(s)
cm	cubic millimeter(s)
dc	discontinue, discharge
dr	dram
CNS	central nervous system
CSF	cerebrospinal fluid
g	gram
gm	gram
gr	grain
gtt	drop
h	hour
HA	headache
hs	hour of sleep (bedtime)
IM	intramuscular
IV	intravenous
kg	kilogram
lb	pound
LOC	level of consciousness
mg	milligram(s)
mgm	milligram(s)
ml	milliliter(s)
NKA	no known allergies

NKDA	no known drug allergies
noct	nocturnal (night)
OTC	over-the-counter
oz	ounce
PDR	Physicians' Desk Reference
PK	pain killers
PM	hours between noon and midnight (afternoon/night)
po	by mouth
PRN	as needed
q	every
qam	every morning
qd	every day
qday	every day
q3h	every three hours
qid	four times a day
R	rectal, right
Rx	"take," prescription
sig	instructions or directions
tab(s)	tablets
tbsp	tablespoon
tid	three times a day
tsp	teaspoon
Tx	treatment, therapy

Special Senses Medical Terminology Worksheet

Please write the meaning of the terms in the right column.

Prefixes, Suffixes, and Root Words

a	
acou/o	
-al	
-ar	
audi/o	
aur/i	
aur/o	
bi-	
bin-	
blephar/o	
cac/o	
chrom/o	
conjunctiv/o	
core/o	
cor/o	
corne/o	
cry/o	
cyst/o	
dacry/o	
dipl/o	
-eal	
-ectomy	
fov	
gloss/o	
-gram	
hyper	
hypo	
-ic	
-ician	
intra	
irid/o	
-ism	
-ist	
-itis	
kerat/o	

labyrinth/o	
lacrim/o	
laryng/o	
lingu/o	
mastoid/o	
medi	
-meter	
-metr/y	
mon/o	
my/o	
myring/o	
nas/o	
ocul/o	
-ocular	
-ologist	
-ology	
ophthalm/o	
-opia	
opt/o	
or/o	
-ory	
osse/o	
-ostomy	
ot/o	
-otomy	
-ous	
-pathy	
-pexy	
pharyng/o	
-pharynx	
-phobia	
-phonia	
phon/o	
phot/o	
-plasty	
-plegia	
presby	
-ptosis	
pupill/o	

retin/o	
rhin/o	
-rrhea	
scler/o	
-scope	
sens	
staped/o	
-stomy	
-tic	
-tomy	
ton/o	
tympan/o	
vitre/o	

Medical Terms

achromatism	
acoustic	
audiogram	
audiometer	
audiometry	
auditory	
auricle	
binocular	
blepharitis	
blepharoplasty	
blepharoptosis	
cacophony	
conjunctivitis	
cryopexy	
dacryocystorhinostomy	
diplopia	
fovea	
glossopharyngeal	
hyperopia	
hypoglossal	
intraocular	
iridectomy	
keratometry	

keratoplasty	
keratotomy	
lacrimal	
mastoiditis	
monochromatic	
myopia	
myringotomy	
ophthalmologist	
ophthalmoplegia	
ophthalmoscope	
optometry	
oral	
oropharynx	
ossicles	
otitis media	
otolaryngologist	
otoscope	
photophobia	
presbyopia	
rhinorrhea	
rhinitis	
rhinoplasty	
retinopathy	
sense	
stapedectomy	
tonometer	
tympanitis	
vitrectomy	
vitreous	

Medical Abbreviations

ENT	
I&D	
O.D.	
O.S.	
O.U.	
PEARL	
cc	

cm	
mm	
gtt	
mg	
ml	
oint	
sig	
PRN	
q	
qam	
qd	
qday	
q2h	
qid	
Rx	
tid	
Tx	
U	

KEY - Special Senses Medical Terminology Worksheet

Prefixes, Suffixes, and Root Words

a	without
acou/o	hearing
-al	pertaining to or expressing relationship
-ar	pertaining to or expressing relationship
audi/o	hearing
aur/i	ear
aur/o	ear
bi-	two
bin-	two
blephar/o	eyelid(s)
cac/o	bad
chrom/o	color
conjunctiv/o	conjunctiva
core/o	pupil
cor/o	pupil
corne/o	cornea
cry/o	cold
cyst/o	sac
dacry/o	tears, tear duct
dipl/o	two
-eal	pertaining to
-ectomy	removal of
fov	pit
gloss/o	tongue
-gram	recorded picture
hyper	above, more than
hypo	below, less than
-ic	pertaining to or expressing relationship
-ician	one who
intra	within
irid/o	iris
-ism	condition of, state of
-ist	a specialist
-itis	inflammation of
kerat/o	cornea

labyrinth/o	labyrinth
lacrim/o	tears
laryng/o	larynx
lingu/o	tongue
mastoid/o	mastoid
medi	middle
-meter	instrument used to measure
-metr/y	measurement
mon/o	one
my/o	muscle, near
myring/o	ear drum
nas/o	nose
ocul/o	eye
-ocular	eye
-ologist	one who studies
-ology	study of
ophthalm/o	eye
-opia	vision
opt/o	vision
or/o	mouth
-ory	referring to
osse/o	bone
-ostomy	creation of an artificial opening
ot/o	ear
-otomy	cut into
-ous	pertaining to
-pathy	disease
-pexy	surgical fixation
pharyng/o	pharynx or throat
-pharynx	throat
-phobia	fear of
-phonia	sound
phon/o	sound
phot/o	light
-plasty	surgical repair
-plegia	paralysis
presby	old
-ptosis	drooping
pupill/o	pupil

retin/o	retina
rhin/o	nose
-rrhea	discharge
scler/o	sclera
-scope	instrument to view
sens	feeling
staped/o	stapes
-stomy	to create an artificial opening
-tic	pertaining to
-tomy	to cut into
ton/o	pressure
tympan/o	ear drum
vitre/o	glass-like

Medical Terms

achromatism	(condition of) absence of color vision
acoustic	pertaining to hearing
audiogram	recording of hearing
audiometer	instrument to measure hearing
audiometry	measurement of hearing
auditory	pertaining to hearing
auricle	pertaining to the (outer) ear
binocular	pertaining to two eyes
blepharitis	inflammation of the eyelid(s)
blepharoplasty	surgical repair of the eyelid(s)
blepharoptosis	drooping of the eyelids
cacophony	bad sound
conjunctivitis	inflammation of the conjunctiva
cryopexy	fixation using cold (used to fix the eyelids in some cases)
dacryocystorhinostomy	surgical creation of an opening between the lacrimal sac and the nose (nasal cavity)
diplopia	double vision
fovea	pit
glossopharyngeal	pertaining to the tongue and pharynx
hyperopia	far vision (referring to far- sightedness)
hypoglossal	pertaining to below the tongue
intraocular	pertaining to within the eye
iridectomy	removal of the iris

keratometry	measurement of the cornea
keratoplasty	repair of the cornea (actually refers to a corneal transplant)
keratotomy	incisions into the cornea (used to correct mild to moderate myopia or nearsightedness)
lacrimal	pertaining to the tear ducts
mastoiditis	inflammation of the mastoid
monochromatic	pertaining to a single color
myopia	near-sightedness
myringotomy	incision into the ear drum
ophthalmologist	one who studies the eyes
ophthalmoplegia	paralysis of the eye(s)
ophthalmoscope	instrument with which to view the eye(s)
optometry	measurement of the eyes
oral	pertaining to the mouth
oropharynx	mouth and throat
ossicles	pertaining to the bones (refers to the tiny middle ear bones)
otitis media	middle ear infection
otolaryngologist	one who studies the ear and larynx
otoscope	instrument to view the ear
photophobia	fear of light (what it really means is to be light sensitive)
presbyopia	aging vision
rhinorrhea	nasal discharge
rhinitis	inflammation of the nose
rhinoplasty	surgical repair of the nose
retinopathy	disease of the retina
sense	feeling
stapedectomy	removal of the stapes (a surgical procedure in which the innermost bone (stapes) of the three bones (the stapes, the incus, and the malleus) of the middle ear is removed, and replaced with a small plastic tube surrounding a short length of stainless steel wire (a prosthesis))
tonometer	instrument to measure pressure (a test that measures the pressure in the eyes to check for glaucoma)
tympanitis	inflammation of the ear drum
vitrectomy	removal of the vitreous or removal of the glass-like fluid
vitreous	pertaining to glass-like (the thick clear glass-like fluid found in the posterior cavity)

Medical Abbreviations

ENT	ear, nose, and throat
I&D	incision and drainage
O.D.	ocular dexter (right eye)
O.S.	ocular sinister (left eye)
O.U.	ocular united (both eyes)
PEARL	pupils equal and reactive to light
cc	cubic centimeter
cm	centimeter
mm	millimeter
gtt	drops
mg	milligram
ml	milliliter
oint	ointment
sig	instructions or directions
PRN	as needed
q	every
qam	every morning
qd	every day
qday	every day
q2h	every two hours
qid	four times a day
Rx	prescription or “to take”
tid	three times a day
Tx	treatment
U	unit