APPENDIX
Cranial Nerves: Anatomy and Physiology

We have 12 cranial nerves; some are sensory nerves, some are motor nerves, and some are part of the autonomic nervous system.

I.	Olfactory	Sensory:	Smell
II.	Optic	Sensory:	Vision
III.	Oculomotor	Motor:	Eye Movements: Innervates all extraocular muscles, except the superior oblique and lateral rectus muscles. Innervates the striated muscle of the eyelid.
		Autonomic:	Mediates pupillary constriction and accommodation for near vision.
IV.	Trochlear	Motor:	Eye Movements: Innervates superior oblique muscle.
V.	Trigeminal	Sensory:	Mediates cutaneous and proprioceptive sensations from skin, muscles, and joints in the face and mouth, including the teeth and the anterior two-thirds of the tongue.
		Motor:	Innervates muscles of mastication.
VI.	Abducens	Motor:	Eye Movements: Innervates lateral rectus muscle.
VII.	Facial	Motor:	Innervates muscles of facial expression.
		Autonomic:	Lacrimal and salivary glands.
		Sensory:	Mediates taste and possible sensation from part of the face (behind the ear).
		Nervous intermedius:	Pain around the ear; possibly taste.
VIII.	Vestibulocochlear	Sensory:	Hearing
			Equilibrium, postural reflexes, orientation of the head in space.
IX.	Glossopharyngeal	Sensory:	Taste
			Innervates taste buds in the posterior third of tongue.
		Sensory:	Mediates visceral sensation from palate and posterior third of the tongue.
			Innervates the carotid body.
		Motor:	Muscles in posterior throat (stylopharyngeal muscle).
		Autonomic:	Parotid gland.
X.	Vagus	Sensory:	Mediates visceral sensation from the pharynx, larynx, thorax, and abdomen.
			Innervates the skin in the ear canal and taste buds in the epiglottis.
		Autonomic:	Contains autonomic fibers that innervate smooth muscle in heart, blood vessels, trachea, bronchi, esophagus, stomach, and intestine.
		Motor:	Innervates striated muscles in the soft palate, pharynx, and the larynx.
XI.	Spinal accessory	Motor:	Innervates the trapezius and sternocleidomastoid muscles.
XII.	Hypoglossal	Motor:	Innervates intrinsic muscles of the tongue.

FUNCTIONS OF THE CRANIAL NERVES

CN I. Olfactory nerve: Communicates chemical airborne messages to the brain.

CN II. Optic nerve: Communicates optic information. Variations in contrast are the most powerful stimulations of the visual system.

CN III. Oculomotor nerve: Controls all of the extraocular eye muscles, except the trochlearis and the lateral rectus muscles; thus, it innervates the superior, the inferior, the medial rectus, and the inferior oblique muscles. This muscle moves the eye in all directions; therefore lesions to CN III affect essentially all eye movements and cause the eye to be deviated downward and outward. It also innervates the eyelid and makes it possible to close the eye when lying down. Lesions to CN III cause ptosis (partial closure of the eyelid). CN III contains autonomic fibers that control the size of the pupil and stretches the lens to achieve accommodation. Lesions to the CN III essentially make the eye useless.

CN IV. Trochlearis nerve: Controls the trochlear muscle, and contraction of this muscle causes the eye to move downward when it is in a position medial to the midline. Lesions of CN IV affect downward and inward movements of the eye.

CN V. Trigeminal nerve: This nerve's sensory portion — the portio major — innervates the skin of the face and the cornea. This portion of CN V thereby communicates sensory information about touch and pain from the face and the mouth. CN V is the nerve that causes toothache and the severe pain of trigeminal neuralgia. Lesions to the sensory portion of CN V cause a loss of sensation of the face. Loss of corneal sensation could result in corneal bruises.

The motor potion of CN V — the portio minor — controls the muscles of mastication. Lesions to the motor portion of CN V cause atrophy of the mastication muscles.

CN VI. Abducens nerve: Controls eye movements from the midline toward the side. Lesion to CN VI prevents movements of the eye from the midline and outward.

CN VII. Facial nerve: Controls the face. CN VII is often monitored intraoperatively because it is at risk in all operations to remove acoustic tumors and it is involved in diseases such as hemifacial spasm. The autonomic fibers of CN VII control both tear glands and salivary glands. A loss of facial function is cosmetically important and makes it difficult to eat, and the lack of tears and the inability to close the eye might result in injures to the cornea.

Nervus intermedius: Perhaps taste. Deep ear pain (geniculate neuralgia).

CN VIII. Vestibulocochlear nerve: The two parts of this nerve communicate auditory information and information about head movements. Whereas the covering of the nerve fibers of most of the brainstem cranial nerves changes from peripheral myelin to central myelin a few millimeters from the brainstem, the transitional zone for CN VIII is in the internal auditory meatus, which means that CN VIII throughout its entire intracranial course is covered with central myelin and it has no epineurium. This means that CN VIII has mechanical properties similar to those of the brain, making it more fragile than other cranial nerves.

The vestibular portion of CN VIII communicates to the brain information gathered by the inner ear about the position of the head. In fact, we can do quite well without the vestibular portion of CN VIII, but if it is injured on one side only, severe balance disturbances can result; however, one can adapt to such dysequilibrium depending on one's age (better when younger than when older).

CN IX. Glossopharyngeal nerve: Communicates sensory information from the throat to the brain and information about blood pressure to the cardiovascular centers. The motor portion of CN IX controls the stylopharyngeal

muscle. Lesions of CN IX will cause a loss of gag reflex on the affected side and a risk of choking on food. Lesions on one side will likely have little effect on cardiovascular function, but a loss of CN IX on both sides is fatal.

CN X. Vagus nerve: This nerve's name means the "vagabondering" nerve, descriptive in that it travels around in a large portion of the body. This nerve conveys parasympathetic input to the entire chest and abdomen. The vagus nerve also controls the vocal cords, the heart, and the diaphragm. The most noticeable effect of unilateral lesions to CN X is hoarseness, because the vocal cord on the affected side cannot close. Although CN X carries information to and from the heart, unilateral lesions to CN X have little effect on the cardiovascular system, but the effect of bilateral severance of the vagal nerve is severe. The vagus nerve might carry more complex sensory information from the lower body.

CN XI. Spinal accessory nerve: Controls muscles in the neck and shoulder (sternocleidomastoid and trapezoid muscles). Lesions of CN XI cause atrophy of the muscles that are innervated by that nerve.

CN XII. Hypoglossal nerve: Controls movements of the tongue. Unilateral lesions to CN XII cause deviation of the tongue and atrophy of the tongue on the affected side. Bilateral lesions make it almost impossible to speak and swallowing is impaired.

Abbreviations

µS:	Microseconds
AAF:	Anterior auditory field
ABI:	Auditory brainstem implants
ABR:	Auditory brainstem response
AI:	Primary auditory cortex
AICA:	Anterior inferior cerebellar artery
AII:	Secondary cortex
AP:	Action potentials
AVCN:	Anterior ventral cochlear nucleus
CAP:	Compound action potentials
CCT:	Central conduction time
cm:	Centimeter
CM:	Cochlear microphonics
CMAP:	Compound muscle action potential
CMN:	Centromedian nucleus
CN I-XII:	Cranial nerves I-XII
CN:	Cochlear nucleus
CNAP:	Compound nerve action potentials
CNS:	Central nervous system
CPA:	Cerebellopontine angle
CPG:	Central pattern generator
CSF:	Cerebrospinal fluid
CT:	Corticospinal tract
DAS:	Dorsal acoustic stria
dB:	Decibel
DBS:	Deep brain stimulation
DC:	Direct electric current
DCN:	Dorsal cochlear nucleus
DPV:	Disabling positional vertigo
DRG:	Dorsal root ganglia
ECoG:	Electrocochleographic
EEG:	Electroencephalographic (potentials)
EKG:	Electrocardiogram (or electrocardiographic)
EMG:	Electromyographic (potentials)
EPSP:	Excitatory postsynaptic potential
GPe:	Globus pallidus external part
CPG:	Central pattern generator
GPi:	Globus pallidus internal part
GPN:	Glosso-pharyngeal neuralgia
HD:	Huntington's disease
HFS:	Hemifacial spasm
HL:	Hearing level
Hz:	Hertz, cycles per second
ICC:	Central nucleus of the inferior colliculus
IPL:	Interpeak latency
ISI:	Inter stimulus interval
kHz:	Kilohertz
kOhm:	Kiloohm
LED:	Light-emitting diodes
LGN:	Lateral geniculate nucleus
LL:	Lateral lemniscus
mA:	Milliampere
ma:	Milliampere
MAC:	Minimal end-alveolar concentration
MCA:	Middle cerebral artery
MEP:	Motor evoked potentials
MGB:	Medial geniculate body
MGP:	Medial segment of globus pallidus
MI:	Primary motor cortex
mm:	Millimeter
MOhm:	Megaohm
ms:	Millisecond
MSO:	Medial superior olivary nucleus
mv:	Millivolts
MVD:	Microvascular decompression (operations)
NF2:	Neurofibromatosis type 2
NIHL:	Noise induced hearing loss
NMEP:	Neurogenic motor evoked potentials
NTB:	Nucleus of the trapezoidal body
PAF:	Posterior auditory field
PD:	Parkinson's disease
PeSPL:	Peak equivalent sound pressure level
PICA:	Posterior inferior cerebellar artery
PMC:	Premotor cortical (areas)
pps:	Pulses per second
PVCN:	Posterior ventral cochlear nucleus
REZ:	Root exit zone (or root entry zone)
RMS:	Root mean square
SI:	Primary somatosensory cortex
SMA:	Supplementary motor area
SNc:	Substantia nigra pars compacta
SNR:	Signal-to-noise ratio
SNr:	Substantia nigra is the pars reticulata
SOC:	Superior olivary complex
SP:	Summating potential
SSEP:	Somatosensory evoked potentials

STN:	Subthalamic nucleus
TC-MEPs:	Transcranial motor evoked potentials
TES:	Transcranial electrical stimulation
TGN:	Trigeminal neuralgia
TIVA:	Total intravenous anesthesia
TN:	Trigeminal neuralgia
V:	Volts
VAS:	Ventral acoustic stria
VEP:	Visual evoked potentials
Vim:	Intermediary nucleus of the thalamus
μS:	Microsecond
μV:	Microvolt
μA:	Microamps

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