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0 ratings0% found this document useful (0 votes)300 viewsSaveSave El Cerebro Humano. Libro de Trabajo - Diamond Sche... For Later0%0% found this document useful, undefinedCentral organ of the human brain, obtained after an
autopsyHuman brain and skullDetailsPrecursorNeural tubeSystemCentral nervous systemArteryInternal carotid arteries, vertebral veins; external veins; external veins (superior, middle, and inferior cerebral veins), basal vein, and cerebellar veinsIdentifiersLatincerebrumGreek (enkphalos)
[1]TA98A14.1.03.001TA25415FMA50801Anatomical terminology[edit on Wikidata]The human brain is the central organ of the nervous system, and with the spinal cord, comprises the central nervous system. It consists of the human brain is the central organ of the human brain is the central organ of the nervous system, and with the spinal cord, comprises the central organ of the nervous system. It consists of the human brain is the central organ of the human brain is the central organ of the nervous system.
and coordinating the information it receives from the sensory nervous system. The brain integrates sensory information and coordinates instructions sent to the rest of the body. The cerebrum, the largest part of the human brain, consists of two cerebral hemispheres. Each hemisphere has an inner core composed of white matter, and an outer surface
the cerebral cortex composed of grey matter. The cortex has an outer layer, the neocortex, and an inner allocortex has three or four. Each hemisphere is divided into four lobes the frontal, parietal, temporal, and occipital lobes. The frontal lobe is associated with executive functions
including self-control, planning, reasoning, and abstract thought, while the occipital lobe is dedicated to vision. Within each lobe, cortical areas are associated with specific functions, such as the sensory, motor, and associated with specific functions, such as the sensory, motor, and associated with specific functions, such as the sensory, motor, and associated with specific functions, such as the sensory, motor, and associated with specific functions are associated with specific functions.
with one side, such as language in the left and visual-spatial ability in the right. The hemispheres are connected by commissural nerve tracts, the largest being the corpus callosum. The pons, and the medulla oblongata. The cerebellum is connected by the brainstem to the spinal cord. The brainstem consists of the midbrain, the pons, and the medulla oblongata. The cerebellum is connected by the brainstem to the spinal cord.
to the brainstem by three pairs of nerve tracts called cerebrum is the ventricular system, consisting of four interconnected ventricles in which cerebrum is the ventricular system, consisting of four interconnected ventricles in which cerebrum is the ventricular system, consisting of four interconnected ventricular system, consisting of four interconnected ventricular system.
hypothalamus, the pituitary gland, and the subthalamus; the limbic structures, including the amygdalae and the hippocampi, the claustrum, the various nuclei of the basal ganglia, the basal forebrain structures, and three circumventricular organs. Brain structures that are not on the midplane exist in pairs; for example, there are two hippocampi and
two amygdalae. The cells of the brain include neurons and supportive glial cells. There are more than 86 billion neurons connect to form neural
pathways, neural circuits, and elaborate network systems. The whole circuitry is driven by the process of neurotransmission. The brain is protected by the skull, suspended in cerebrospinal fluid, and isolated from the bloodstream by the bloodstream by the bloodstream by the bloodstream by the process of neurotransmission. The whole circuitry is driven by the skull, suspended in cerebrospinal fluid, and isolated from the bloodstream by the skull, suspended in cerebrospinal fluid, and isolated from the bloodstream by the b
by trauma, or a loss of blood supply known as a stroke. The brain is susceptible to degenerative disorders, such as Parkinson's disease, dementias including Alzheimer's disease, and multiple sclerosis. Psychiatric conditions, including schizophrenia and clinical depression, are thought to be associated with brain dysfunctions. The brain can also be the
site of tumours, both benign and malignant; these mostly originate from other sites in the body. The study of the anatomy of the brain is neuroscience. Numerous techniques are used to study the brain is neuroscience, which may be examined microscopically, have traditionally provided
much information. Medical imaging technologies such as functional neuroimaging, and electroencephalography (EEG) recordings are important in studying the brain. Neuroscience research has expanded considerably, and research is
ongoing. In culture, the philosophy of mind has for centuries attempted to localise personality attributes to regions of the cortex in the 19th century. In science fiction, brain transplants are imagined in tales such as the 1942
Donovan's Brain. Human brain (sagittal section) See also: Evolution of the human brain weighs on average about 1.21.4kg (2.63.1lb) which is about 2% of the total body weight, [2][3] with a volume of around 1260cm3 in men
and 1130cm3 in women.[4] There is substantial individual variation,[4] with the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.273.09lb).[6]The cerebrum, consisting of the cerebrum of the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.273.09lb).[6]The cerebrum of the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.273.09lb).[6]The cerebrum of the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.273.09lb).[6]The cerebrum of the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.273.09lb).[6]The cerebrum of the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.273.09lb).[6]The cerebrum of the standard reference range for men being 1,1801,620g (2.603.57lb)[5] and for women 1,0301,400g (2.603.57lb)[6] and f
hemispheres, the cerebral cortex, is grey matter, consisting of cortical layers of neurons. Each hemisphere is divided into four main lobe, and occipital lobe, and an insular lobe, and an insular lobe. [8] Three other lobes are included by some sources which are a central lobe, and an insular lobe, and an insular lobe, temporal lobe, and occipital lobe, and occipi
precentral gyrus and the postcentral gyrus and is included since it forms a distinct functional role.[9][10]The brainstem, resembling a stalk, attaches to and leaves the cerebrum at the start of the midbrain area. The brainstem is the cerebrum at the start of the midbrain area.
cerebrum, brainstem, cerebellum, and spinal cord are covered by three membranes called meninges. The membranes are the tough dura mater is the subarachnoid space and subarachnoid cisterns, which contain the cerebrospinal
fluid.[11] The outermost membrane of the bloodbrain barrier.[12] In 2023 a fourth meningeal membrane has been proposed known as the subarachnoid lymphatic-like membrane for the bloodbrain barrier.[12] In 2023 a fourth meningeal membrane has been proposed known as the subarachnoid lymphatic-like membrane of the pia mater called the glia limitans and is an important part of the bloodbrain barrier.[12] In 2023 a fourth meningeal membrane has been proposed known as the subarachnoid lymphatic-like membrane of the pia mater called the glia limitans and is an important part of the bloodbrain barrier.[12] In 2023 a fourth meningeal membrane has been proposed known as the subarachnoid lymphatic-like membrane of the pia mater called the glia limitans and is an important part of the bloodbrain barrier.[13] In 2023 a fourth meningeal membrane has been proposed known as the subarachnoid lymphatic-like membrane of the pia mater called the glia limitans and is an important part of the bloodbrain barrier.[13] In 2023 a fourth meningeal membrane has been proposed known as the subarachnoid lymphatic-like membrane of the pia mater called the glia limitans and is an important part of the bloodbrain barrier.[13] In 2023 a fourth membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like membrane has been proposed known as the subarachnoid lymphatic-like has been proposed known as the subarachnoid lymphatic-like has been proposed known as the subarachnoid lymphatic-like has been proposed kn
consistency similar to soft tofu.[15] The cortical layers of neurons constitute much of the brain makes up about half of the total brain volume.[16] Structural and functional areas of the human brain Human brain
bisected in the sagittal plane, showing the white matter of the corpus callosum and Cerebrum and
divided into nearly symmetrical left and right hemispheres by a deep groove, the longitudinal fissure. [17] Asymmetry between the longitudinal fissure, the largest of these is noted as a petalia. [18] The hemisphere are connected by five commissures that span the longitudinal fissure, the largest of these is noted as a petalia.
main lobes; the frontal lobe, parietal lobe, and occipital lobe, and occipital lobe, and occipital lobe, and occipital lobe, temporal lobe, and occipital lobe, temporal lobe, temporal lobe, the swill be surface of the brain is folded into ridges (gyri) and grooves (sulci), many of which are
named, usually according to their position, such as the frontal gyrus of the central sulcus separating the central regions of the hemispheres. There are many small variations in the secondary and tertiary folds. [20] The outer part of the cerebrum is the cerebrum is the cerebrum is the cerebrum is the central regions of the hemispheres. There are many small variations in the secondary and tertiary folds.
(0.079 to 0.157in) thick, and deeply folded to give a convoluted appearance. [21] Beneath the cortex is the neocortex, which has six neuronal layers. The rest of the cortex is mapped by divisions into about fifty different
functional areas known as Brodmann's areas. These areas are distinctly different when seen under a microscope. [22] The cortex is divided into two main functional areas a motor cortex, which sends axons down to motor neurons in the brainstem and spinal cord, occupies the rear portion of the
frontal lobe, directly in front of the somatosensory areas include the visual cortex of the auditory cortex in parts of the temporal lobe and insular cortex, and the somatosensory cortex in the
parietal lobe. The remaining parts of the cortex are called the association areas. These areas receive input from the sensory areas and lower parts of the brain and are involved in the complex cognitive processes of perception, thought, and decision-making. [24] The main functions of the frontal lobe are to control attention, abstract thinking,
behaviour, problem-solving tasks, and physical reactions and personality.[25][26] The occipital lobe is the smallest lobe; its main functions are visual reception, visual-spatial processing, movement, and colour recognition.[25][26] There is a smaller occipital lobule in the lobe known as the cuneus. The temporal lobe controls auditory and visual
memories, language, and some hearing and speech.[25]Cortical folds and white matter in horizontal bisection of headThe cerebrum contains the ventricles where the cerebrum contains the ventricles where the cerebrum contains the ventricles. Below the corpus callosum is the septum pellucidum, a membrane that separates the lateral ventricles. Below the corpus callosum is the ventricles where the cerebrum contains the ventricles.
the thalamus and to the front and below is the hypothalamus. The hypothalamus. The hypothalamus leads on to the pituitary gland. At the back of the thalamus is the brainstem. [27] The basal ganglia, also called basal nuclei, are a set of structures deep within the hemispheres involved in behaviour and movement regulation.
others are the globus pallidus, the substantia nigra and the substantia nigra nig
nucleus and the putamen. The putamen and the globus pallidus lie separated from the lateral ventricles on their outer sides. [29] At the deepest part of the lateral sulcus between the insular cortex and the striatum is a thin neuronal
sheet called the claustrum.[30]Below and in front of the striatum are a number of basal forebrain structures. These include the nucleus basalis, diagonal band of Broca, substantia innominata, and the medial septal nucleus. These include the nucleus basalis, diagonal band of Broca, substantia innominata, and the medial septal nucleus.
brain. The basal forebrain, in particular the nucleus basalis, is considered to be the major cholinergic output of the central nervous system to the striatum and neocortex.[31]Human brain viewed from below, showing cerebellum and brainstemMain article: CerebellumThe cerebellum is divided into an anterior lobe, a posterior lobe, and the
flocculonodular lobe.[32] The anterior and posterior lobes are connected in the middle by the vermis.[33] Viewed from underneath between the two lobes is the third lobe the flocculonodular lobe
[34] The cerebellum rests at the back of the cranial cavity, lying beneath the occipital lobes, and is separated from these by the cerebellar peduncles. The superior pair connects to the middle pair connects to the medulla, and
the inferior pair connects to the pons.[33] The cerebellum consists of an inner medulla of white matter and an outer cortex of richly folded grey matter.[35] The cerebellum's anterior and posterior lobes appear to play a role in the coordination and smoothing of complex motor movements, and the flocculonodular lobe in the maintenance of
balance[36] although debate exists as to its cognitive, behavioural and motor functions.[37]Main article: BrainstemThe brainstem lies beneath the cerebrum and consists of the midbrain, pons and medulla. It lies in the back part of the skull, resting on the part of the base known as the clivus, and ends at the foramen magnum, a large opening in the
occipital bone. The brainstem continues below this as the spinal cord,[38] The brainstem also contains many cranial nerves, as well as nuclei involved in the regulation of many essential processes
including breathing, control of eye movements and balance. [38] The reticular formation, a network of nuclei of ill-defined formation, is present within and along the length of the brainstem. [38] The reticular formation, is present within and along the length of the brainstem.
primarily composed of neurons, glial cells, neural stem cells, and blood vessels. Types of neurons (upper and lower motor neurons), and cerebellar Purkinje cells including Betz cells (by size of cell body) in the nervous system. [40] The adult human brain is estimated to
contain 868 billion neurons, with a roughly equal number (8510 billion) of non-neuronal cells.[41] Out of these neurons, 16 billion (19%) are located in the cerebellum.[3][41] Types of glial cell are astrocytes (including Bergmann glia), oligodendrocytes, ependymal cells (including tanycytes), radial glial
cells, microglia, and a subtype of oligodendrocyte progenitor cells. Astrocytes are the largest of the glial cells with many processes end as perivascular endfeet on capillary walls. [42] The glia limitans of the cortex is made up of astrocyte endfeet processes that serve in
part to contain the cells of the brain.[12]Mast cells are white blood cells that interact in the neuroimmune system in the brain.[43] Mast cells in the central nervous system are present in a number of structures including the meninges;[43] they mediate neuroimmune responses in inflammatory conditions and help to maintain the bloodbrain barrier,
particularly in brain regions where the barrier is absent.[43][44] Mast cells serve the same general functions in the body and central nervous system, such as effecting or regulating allergic responses, innate and adaptive immunity, autoimmunity, autoimm
biochemical signaling that takes place between the gastrointestinal tract and the central nervous system.[45][46]Some 400 genes are shown to be brain-specific. In all neurons, ELAVL3 is expressed, and in pyramidal cells, NRGN and REEP2 are also expressed. GAD1 essential for the biosynthesis of the neurotransmitter GABA is expressed in
interneurons. Proteins expressed in glial cells include astrocyte markers GFAP and S100B whereas myelin basic protein and the transcription factor OLIG2 are expressed in oligodendrocytes.[47]Cerebrospinal fluid circulates in spaces around and within the brainMain article: Cerebrospinal fluid Cerebrospinal fluid is a clear, colourless transcellular
fluid that circulates around the brain in the subarachnoid space, known as subarachnoid space, known as subarachnoid space, known as subarachnoid cisterns. [48] The four ventricles, at hird, and a fourth ventricle, all contain a choroid plexus that produces cerebrospinal fluid. [49]
The third ventricle lies in the midline and is connected to the lateral ventricles.[48] A single duct, the cerebral aqueduct between the pons and the cerebral aqueduct between the pons and the cerebral appearance openings, the middle and two lateral appearance openings.
magna, one of the major cisterns. From here, cerebrospinal fluid circulates around the brain and spinal cord in the subarachnoid space, between the arachnoid space. It is constantly being regenerated and absorbed, and is replaced
about once every 56 hours. [48] A glymphatic system has been described as the lymphatic drainage system of the brain. [51] [52] The brain-wide glymphatic vessels that are associated with the dural sinuses, and run alongside the cerebral blood vessels
[53][54] The pathway drains interstitial fluid from the tissue of the brain.[54]Main article: Cerebral circulationTwo circulationTwo circulations joining at the circle of Willis (inferior view)Diagram showing features of cerebral curve in the brain and the vertebral circulationTwo circulati
arteries supply blood to the back of the brain.[55] These two circulations join in the circle of Willis, a ring of connected arteries are branches of the common carotid arteries. They enter the cranium through the carotid canal, travel through the
cavernous sinus and enter the subarachnoid space.[57] They then enter the circle of Willis, with two branches, the anterior cerebral arteries emerging. These branches travel forward and then upward along the longitudinal fissure, and supply the front and midline parts of the brain.[58] One or more small anterior communicating arteries join the two
anterior cerebral arteries shortly after they emerge as branches. [58] The internal carotid arteries continue forward as the middle cerebral arteries shortly after they emerge as branches along the insula cortex, where final branches arise. They middle cerebral arteries send branches along their length. [57] The
vertebral arteries emerge as branches of the left and right subclavian arteries. They travel upward through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through transverse foramina which are spaces in the cervical vertebral enters the cranial cavity through the foramen magning the corresponding side of the medula. [57] They give off one of the three cerebellar branches.
arteries join in front of the middle part of the medulla and pons, and the two other anterior cerebellar branches to supply the medulla and pons, and the two other anterior cerebellar branches to supply the medulla and pons, and the two other anterior cerebellar branches. [59] Finally, the basilar artery divides into two posterior cerebellar branches to supply the medulla and pons, and the two other anterior and superior cerebellar branches.
peduncles, and along the top of the cerebellar tentorium, where it sends branches to supply the temporal and occipital lobes. [59] Each posterior cerebral artery sends a small posterior communicating artery to join with the internal carotid arteries. Cerebral veins drain deoxygenated blood from the brain. The brain has two main networks of veins: an
exterior or superficial network, on the surface of the cerebrum that has three branches, and an interior networks communicate via anastomosing (joining) veins. [60] The veins of the brain drain into larger cavities of the dural venous sinuses usually situated between the dura mater and the covering of the skull. [61] Blood from the
cerebellum and midbrain drains into the great cerebral vein. Blood from the medulla and pons of the brainstem have a variable pattern of drainage, either into the spinal veins at the front, and the superior and inferior
petrosal sinuses at the sides, and the inferior sagittal sinus at the back.[61] Blood drains from the outer brain into the left and right transverse sinuses.[61]
These then drain into the sigmoid sinuses, which receive blood from the cavernous sinus and superior and inferior petrosal sinuses. These smaller capillaries. These smallest of blood vessels in the brain, are lined with cells joined by tight
 (including anaesthetics and alcohol).[44] The blood-brain barrier is not present in the circumventricular organswhich are structures in the brain that may need to respond to changes in body fluidssuch as the pineal gland, area postrema, and some areas of the hypothalamus.[44] There is a similar bloodcerebrospinal fluid barrier, which serves the
same purpose as the bloodbrain barrier, but facilitates the transport of different substances into the brain due to the distinct structural characteristics between the two barrier systems. [44][63]Main article: Development of the human brainNeurulation and neural crest cellsPrimary
bends sharply forward in a cephalic flexure.[67] This flexed part becomes the forebrain (prosencephalon); the adjoining curving part becomes the midbrain (mesencephalon) and the part caudal to the flexure becomes the hindbrain (mesencephalon). These areas are formed as swellings known as the three primary brain vesicles. In the fifth week of the flexure becomes the midbrain (mesencephalon) and the part becomes the midbrain (mesencephalon) and the part becomes the midbrain (mesencephalon).
development five secondary brain vesicles have formed.[70] The forebrain separates into two vesicles an anterior telencephalon and a posterior diencephalon gives rise to the thalamus and hypothalamus. The hindbrain also splits into two
areas the metencephalon and the myelencephalon gives rise to the medulla oblongata.[71] Also during the fifth week, the brain divides into repeating segments called neuromeres.[65][72] In the hindbrain these are known as rhombomeres.[73]A characteristic of the brain divides into repeating segments called neuromeres.[65][72] In the hindbrain these are known as rhombomeres.[73]A characteristic of the brain divides into repeating segments.
is the cortical folding known as gyrification. For just over five months of prenatal development the cortex is smooth. By the gestational age of 24 weeks, the wrinkles and folds is not well-understood, but gyrification has been linked to
intelligence and neurological disorders, and a number of gyrification theories have been proposed. [74] These theories include those based on mechanical buckling, [75] [19] axonal tension, [76] and differential tangential expansion.
process which generates patterns of folds that are consistent between individuals and most species. [75][77]The first groove to appear in the fourth month is the lateral cerebral fossa. [69] The expanding caudal end of the hemisphere has to curve over in a forward direction to fit into the restricted space. This covers the fossa and turns it into a much
deeper ridge known as the lateral sulcus and this marks out the temporal lobe.[69] By the sixth month other sulci have formed that demarcate the frontal, parietal, and occipital lobes.[69] A gene present in the human genome (ARHGAP11B) may play a major role in gyrification and encephalisation.[78]Brain of human embryo at 4.5 weeks, showing
interior of forebrainBrain interior at 5 weeksBrain viewed at midline at 3 monthsMotor and sensory regions of the brainThe frontal lobe is involved in planning and coordinating movement; the prefrontal cortex, which is responsible for higher-level
cognitive functioning; and Broca's area, which is essential for language production. [79] The motor system of the brain is responsible for the generation and control of movements pass from the brain is responsible for the generation and control of movements.
from the brain, through the spinal cord, to the torso and limbs.[81] The cranial nerves carry movements related to the eyes, mouth and face. Gross movement such as locomotion and the movement of arms and legs is generated in the motor cortex, divided into three parts: the primary motor cortex, found in the precentral gyrus and has sections
dedicated to the movement of different body parts. These movements are supported and regulated by two other areas, lying anterior to the primary motor cortex: the premotor area and the supplementary motor area. [82] The hands and mouth have a much larger area dedicated to them than other body parts, allowing finer movement; this has been
visualised in a motor homunculus.[82] Impulses generated from the motor cortex travel along the corticospinal tract along the front of the medullary pyramids. These then travel down the spinal cord, with most connecting to interneurons, in turn connecting to lower motor neurons within the grey matter that
then transmit the impulse to move to muscles themselves. [81] The cerebellum and basal ganglia, play a role in fine, complex and coordinated muscle movement initiation, and are referred to as the extrapyramidal system. [84] Cortical areas Routing
of neural signals from the two eyes to the brainThe sensory nervous system is involved with the reception and processing of sensory information. This information is received through the cranial nerves, through tracts in the spinal cord, and directly at centres of the brain exposed to the blood.[85] The brain also receives and interprets information
from the special senses of vision, smell, hearing, and taste. Mixed motor and sensory signals are also integrated. [85] From the brain receives information about fine touch, pressure, pain, vibration and temperature. From the joints, the brain receives information about fine touch, pressure, pain, vibration and temperature.
and, like the motor cortex, has areas related to sensation from different body parts. Sensation collected by a sensory receptor on the skin is changed to a nerve signal, that is passed up a series of neurons through tracts in the spinal cord. The dorsal columnmedial lemniscus pathway contains information about fine touch, vibration and position of
joints. The pathway fibres travel up the back part of the spinal cord to the back part of the medulla, where they connect with second-order neurons that immediately send fibres across the midline. These fibres then travel upwards into the ventrobasal complex in the thalamus where they connect with third-order neurons which send fibres up to the
 sensory cortex.[86] The spinothalamic tract carries information about pain, temperature, and gross touch. The pathway fibres travel up the spinal cord and connect with second-order neurons in the reticular formation of the brainstem for gross touch.[87]Vision is
generated by light that hits the retina of the eye. Photoreceptors in the retina transduce the sensory stimulus of light into an electrical nerve signal that is sent to the visual field to be received by the rightmost portion of each retina, and vice versa. This
arrangement ultimately means that a portion of each retina is processed by each hemisphere of the cortex, such that both the right and left visual cortex process information from both eyes. Visual signals leave the retinas through the optic nerve fibres from the
temporal halves of the opposite retinas, which do not cross, forming the optic tracts. The optic tracts. The optic tracts fibres reach the brain at the lateral geniculate nucleus, and travel through the optic tracts fibres reach the brain at the lateral geniculate nucleus, and travel through the optic tracts. The optic tracts fibres reach the brain at the lateral geniculate nucleus, and travel through the optic tracts.
the hearing organ, and change in balance results in movement of liquids within the inner ear. This creates a nerve signal that passes through to the cochlear nucleus, and finally the auditory radiation to the auditory cortex. [89] The
sense of smell is generated by receptor cells in the epithelium of the olfactory mucosa in the nasal cavity. This information passes via the olfactory bulb from where information is passed to the olfactory cortex. [90][91] Taste
is generated from receptors on the tongue and passed along the facial and glossopharyngeal nerves into the solitary nucleus in the brainstem. Some taste information is also passed from the thalamus into the gustatory cortex. [92] Autonomic functions of the
brain include the regulation, or rhythmic control of the heart rate and rate of breathing, and maintaining homeostasis. Blood pressure and heart rate are influenced by the vasomotor centre of the medulla, which causes arteries and veins to be somewhat constricted at rest. It does this by influencing the sympathetic and parasympathetic nervous
systems via the vagus nerve.[93] Information about blood pressure is generated by baroreceptors in aortic bodies in the arotic arch, and passed to the brain along the afferent fibres of the vagus nerve. Information about the pressure changes in the carotid sinus comes from carotid bodies located near the carotid artery and this is passed via a nerve
joining with the glossopharyngeal nerve. This information travels up to the solitary nucleus in the medulla. Signals from here influence the vasomotor centre to adjust vein and artery constriction accordingly. [94] The brain controls the rate of breathing, mainly by respiratory centres in the medulla and pons. [95] The respiratory centres control
respiration, by generating motor signals that are passed down the spinal cord, along the phrenic nerve to the diaphragm and other muscles of respiration. This is a mixed nerve that carries sensory information back to the centres. There are four respiratory centres, three with a more clearly defined function, and an apneustic centre with a less clear
function. In the medulla a dorsal respiratory group causes the desire to breathe in and receives sensory information directly from the body. Also in the medulla, the ventral respiratory group influences the duration of each breath, [95] and the apneustic centre seems to have
an influence on inhalation. The respiratory centres directly senses blood carbon dioxide and pH. Information about blood oxygen, carbon dioxide and pH levels are also sensed on the walls of arteries in the peripheral chemoreceptors of the aortic and carotid bodies. This information is passed via the vagus and glossopharyngeal nerves to the
respiratory centres. High carbon dioxide, an acidic pH, or low oxygen stimulate the respiratory centres (95] The desire to breathe in is also affected by pulmonary stretch receptors in the lungs which, when activated, prevent the lungs from overinflating by transmitting information to the respiratory centres via the vagus nerve.
in the diencephalon, is involved in regulating many functions of the body. Functions include neuroendocrine regulation of fluid, and food intake. The circadian rhythm, controlled by two main cell groups in the hypothalamus. The anterior hypothalamus in the regulation of fluid, and food intake.
includes the suprachiasmatic nucleus and the ventrolateral preoptic nucleus which through gene expression cycles, generates a roughly 24 hour circadian clock. In the circadian day an ultradian rhythm takes control of the sleeping pattern. Sleep is an essential requirement for the body and brain and allows the closing down and resting of the body's
systems. There are also findings that suggest that the daily build-up of toxins in the brain are removed during sleep.[96] Whilst awake the brain consumes a fifth of the body's total energy needs. Sleep necessarily reduces this use and gives time for sleep.
[97]The lateral hypothalamus contains or exinergic neurons that control appetite and arousal through the release of peptides such as oxytocin, and vasopressin, as well as dopamine into the median eminence. Through the
autonomic projections, the hypothalamus is involved in regulating functions such as blood pressure, heart rate, breathing, sweating, and other homeostatic mechanisms.[100] The hypothalamus is involved in regulation, and when stimulated by the immune system, is capable of generating a fever. The hypothalamus is influenced by the
kidneys: when blood pressure falls, the renin released by the kidneys stimulates a need to drink. The hypothalamus also regulates food intake through autonomic signals, and hormone release by the digestive system.[101]Broca's area and Wernicke's area are linked by the arcuate fasciculus. Main article: Language processing in the brainSee also:
Two-streams hypothesis Two auditory systemsWhile language functions were traditionally thought to be localised to Wernicke's area and Broca's area,[102] it is now mostly accepted that a wider network of cortical regions contributes to language functions.[103][104][105]The study on how language is represented, processed, and acquired by the
brain is called neurolinguistics, which is a large multidisciplinary field drawing from cognitive neuroscience, cognitive linguistics, and psycholinguistics, an
hemisphere of the brain interacting primarily with one half of the body: the left side of the brain interacts with the right side of the brain to the spinal cord, and sensory connections from the spinal cord to the brain, both cross sides in
the brainstem. Visual input follows a more complex rule: the optic chiasm, and half of the retina, in both eyes, go to the left side of the brain, whereas connections from the righ
half of the retina go to the right side of the brain. [109] Because each half of the visual input from the opposite half of the visual input from the prain receives somatosensory input from
the left side of the body, and visual input from the left and right hand is the right-hemisphere area controlling the left hand. There are, however,
several important exceptions, involving language and spatial cognition. The left frontal lobe is dominant for language area in the left hemisphere would cause only minor impairment to language skills. A
substantial part of current understanding of the interactions between the two hemispheres has come from the study of "split-brain patients" people who underwent surgical transection of the corpus callosum in an attempt to reduce the severity of epileptic seizures. [114] These patients do not show unusual behaviour that is immediately obvious, but in
some cases can behave almost like two different people in the same body, with the right and taking an action and then the left hand undoing it.[114][115] These patients, when briefly shown a picture on the right side of the point of visual fixation, are able to describe it verbally, but when the picture is shown on the left, are unable to describe it, but
may be able to give an indication with the left hand of the nature of the object shown.[115][116]Main article: EmotionFurther information: Affective neuroscienceEmotions are generally defined as two-step multicomponent processes involving elicitation, followed by psychological feelings, appraisal, expression, autonomic responses, and action
tendencies.[117] Attempts to localise basic emotions to certain brain regions have been controversial; some research found no evidence for specific locations corresponding to emotions, but instead found circuitry involved in general emotions, but instead found circuitry involved in general emotions to certain brain regions have been controversial; some research found no evidence for specific locations corresponding to emotions, but instead found circuitry involved in general emotions, but instead found circuitry involved in general emotions.
appeared to be involved in generating the emotions, while weaker evidence was found for the ventral tegmental area, ventral pallidum and nucleus accumbens in incentive salience. [118] Others, however, have found evidence of activation of specific regions, such as the basal ganglia in happiness, the subcallosal cingulate cortex in sadness, and
amygdala in fear.[119]Main article: Cognition Further information: Prefrontal cortex Executive functions.[121][122][123] Executive functions include the ability to filter information and tune out irrelevant stimuli with attentional
control and cognitive inhibition, the ability to process and manipulate information held in working memory, the ability to inhibit impulses and prepotent responses with inhibitory control, and the ability to determine the relevance of information or
appropriateness of an action.[122][123] Higher order executive functions require the simultaneous use of multiple basic executive functions, and include planning, prospection and fluid intelligence (i.e., reasoning and problem solving).[123][124] Planning involves
activation of the dorsolateral prefrontal cortex (DLPFC), anterior cingulate cortex, angular prefrontal cortex, and supramarginal gyrus, and areas of the parietal cortex. [121][124] Inhibitory control involves multiple areas of the prefrontal cortex, as
well as the caudate nucleus and subthalamic nucleus.[123][124][125]Main article: NeurotransmissionFurther information: Summation (neurophysiology)Brain activity is made possible by the interconnections of neurons that are linked together to reach their targets.[126] A neuron consists of a cell body, axon, and dendrites. Dendrites are often
extensive branches that receive information in the form of signals from the axon terminals of other neurons. The signals received may cause the neuron to initiate an action potential (an electrochemical signal or nerve impulse) which is sent along its axon to the axon terminal, to connect with the dendrites or with the cell body of another neuron. An
action potential is initiated at the initial segment of an axon, which contains a specialised complex of proteins.[127] When an action potential reaches the target cell.[128] These chemical neurotransmitters include dopamine, serotonin,
GABA, glutamate, and acetylcholine.[129] GABA is the major inhibitory neurotransmitter in the brain, and glutamate is the major excitatory neurotransmitter network systems such as the salience network and the default mode network, and the activity
between them is driven by the process of neurotransmission.PET image of the human brain showing energy consumptionThe brain consumes up to 20% of the energy for most cells and is critical for normal function in a number of
tissues, including the brain.[132] The human brain consumes approximately 60% of blood glucose in fasted, sedentary individuals.[132] Brain metabolism normally relies upon blood glucose as an energy source, but during times of low glucose (such as fasting, endurance exercise, or limited carbohydrate intake), the brain uses ketone bodies for fuel
with a smaller need for glucose. The brain can also utilize lactate during exercise.[133] The brain stores glucose in the form of glycogen, albeit in significantly smaller amounts than that found in the liver or skeletal muscle.[134] Long-chain fatty acids cannot cross the bloodbrain barrier, but the liver can break these down to produce ketone bodies.
However, short-chain fatty acids (e.g., butyric acid, propionic acid, and acetic acid) and the medium-chain fatty acids, octanoic acid and heptanoic acid and heptanoic acid, can cross the bloodbrain barrier and be metabolised by brain cells.[135][136][137]Although the human brain represents only 2% of the body weight, it receives 15% of the cardiac output, 20% of total
body oxygen consumption, and 25% of total body glucose utilization.[138] The energy consumption of the brain does not vary greatly over time, but active regions of the cortex consume somewhat more energy.
than inactive regions, which forms the basis for the functional neuroimaging methods of PET and fMRI.[140] These techniques provide a three-dimensional image of metabolic activity.[141] A preliminary study showed that brain metabolic requirements in humans peak at about five years old.[142]The function of sleep is not fully understood; however
there is evidence that sleep enhances the clearance of metabolic waste products, some of which are potentially neurotoxic, from the brain and may also permit repair. [52][143][144] Evidence suggests that the increased clearance of metabolic waste during sleep occurs via increased functioning of the glymphatic system. [52] Sleep may also have an
effect on cognitive function by weakening unnecessary connections.[145] The brain is not fully understood, and research is ongoing.[146] Neuroscientists, along with researchers from allied disciplines such as psychiatry have
faded as they are all influenced by basic research in neuroscience. Neuroscience research has expanded considered to have marked much of this increase in research, [147] and was followed in 2013 by the BRAIN Initiative. [148] The Human
Connectome Project was a five-year study launched in 2009 to analyse the anatomical and functional connections of parts of the brain, and has provided much data.[146]An emerging phase in research may be that of simulating brain activity.[149]Information about the structure and function of the human brain comes from a variety of experimental
Measurements may be of local field potentials of cortical areas, or of the activity of a single neuron. An electroencephalogram can record the electrocorticography, which uses electrodes placed directly on the exposed surface of the
brain. This method is used in cortical stimulation mapping, used in the study of the relationship between cortical areas and their systemic function. [152] By using much smaller microelectrodes, single-unit recordings can be made from a single neuron that give a high spatial resolution and high temporal resolution. This has enabled the linking of brain
brainFMRI of healthy human brainFunctional neuroimaging technique is functional magnetic resonance imaging (fMRI) which has the advantages over earlier methods of SPECT and PET of not needing the use of radioactive materials and of offering a
higher resolution.[156] Another technique is functional near-infrared spectroscopy. These methods rely on the haemodynamic response that shows changes in brain activity in relation to changes in blood flow, useful in mapping functions to brain areas.[157] Resting state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions whilst the brain is not performing a state fMRIlooks at the interaction of brain regions while the brain is not performing a state fMRIlooks at the brain regions at the brain regions at the brain regions at the brain regions at the brain region of brain regions at the brain region of the br
specific task.[158] This is also used to show the default mode network. Any electrical current generates a magnetic field; neural oscillations induce weak magnetic fields, and in functional magnetoencephalography the current produced can show localised brain function in high resolution. [159] Tractography uses MRI and image analysis to create 3D
images of the nerve tracts of the brain. Connectograms give a graphical representation of the neural connections of the brain. [160] Differences in brain structure can be measured in some disorders, notably schizophrenia and dementia. Different biological approaches using imaging have given more insight for example into the disorders of depression
                        ulsive disorder. A key source of information about the function of brain regions is the effects of damage to them. [161] Advances in neuroimaging have enabled objective insights into mental disorders, leading to faster diagnosis, more accurate prognosis, and better monitoring. [162] Main article: Bioinformatics See also: List of
neuroscience databases Bioinformatics is a field of study that includes the creation and advancement of databases, and computational and statistical techniques, that can be used in studies in genomics, and functional genomics, generated the need
for DNA annotation, a transcriptome technology, identifying genes, their locations and functions. [163][164][165] GeneCards is a major database. As of 2017 [update], just under 20,000 protein-coding genes are seen to be expressed in the human, [163] and some 400 of these genes are brain-specific. [166][167] The data that has been provided on gene
factor causing the drive to alcohol dependence, and also to other substance abuses.[169]Other related studies have also shown evidence of synaptic alterations and their loss, in the ageing brain. Changes in gene expression alter the levels of proteins in various neural pathways and this has been shown to be evident in synaptic contact dysfunction or
loss. This dysfunction has been seen to affect many structures of the brain and has a marked effect on inhibitory neurons resulting in a decreased level of neurotransmission, and subsequent cognitive decline and disease. [170][171]Injury to the brain can manifest in many ways. Traumatic brain injury, for example received in contact sport, after a fall,
or a traffic or work accident, can be associated with both immediate and longer-term problems. Immediate problems may include bleeding within the brain tissue or damage its blood supply. Bruising to the brain tissue or damage its blood supply. Bruising to the brain may occur. Bruising may cause widespread damage to the nerve tracts that can lead to a condition of diffuse
axonal injury.[172] A fractured skull, injury to a particular area, deafness, and concussion are also possible immediate developments. In addition to the site of injury, the opposite side of the brain may be affected, termed a contrecoup injury. Longer-term issues that may develop include posttraumatic stress disorder, and hydrocephalus. Chronic
traumatic encephalopathy can develop following multiple head injuries.[173]Neurodegenerative diseases result in progressive damage to, or loss of neurons affecting different functions of the brain, that worsen with age. Common types are dementia, vascular dementia, and Parkinson's disease
dementia. Other rarer infectious, genetic, or metabolic types include Huntington's disease, motor neuron diseases, HIV dementia, syphilis-related dementia and Wilson's disease. Neurodegenerative diseases can affect different parts of the brain, and can affect movement, memory, and cognition.[174] Rare prion diseases including CreutzfeldtJakob
disease and its variant, and kuru are fatal neurodegenerative diseases.[175]Cerebral atherosclerosis is atherosclerosis that affects the brain. It results from the build-up of plaques formed of cholesterol, in the large arteries of the brain. It results from the build-up of plaques formed of cholesterol, in the large arteries of the brain. It results from the build-up of plaques formed of cholesterol, in the large arteries of the brain.
contributes to the development of dementia, and has protein similarities to those found in Alzheimer's disease. [176] The brain, although protected by the bloodbrain barrier, can be affected by infections including viruses, bacteria and fungi. Infection may be of the meninges (meningitis), the brain matter (encephalitis), or within the brain matter (such
as a cerebral abscess).[175]Brain tumours can be either benign or cancerous. Most malignant tumours arise from another part of the body, most commonly from the lung, breast and skin.[177] Cancers of brain tissue can also occur, and originate from any tissue in and around the brain. Meningioma, cancer of the meninges around the brain, is more
common than cancers of brain tissue.[177] Cancers within the brain may cause symptoms related to their size or position, with symptoms including headache and nausea, or the gradual development of focal symptoms such as gradual difficulty seeing, swallowing, talking, or as a change of mood.[177] Cancers are in general investigated through the
use of CT scans and MRI scans. A variety of other tests including blood tests and lumbar puncture may be used to investigate for the cause of the cancer. [177] The corticosteroid dexamethasone is often given to decrease the swelling of brain tissue around a tumour. Surgery may be considered, however
given the complex nature of many tumours or based on tumour stage or type, radiotherapy or chemotherapy may be considered more suitable.[177]Mental disorder, posttraumatic stress disorder, posttraumatic stress disorder, attention deficit hyperactivity disorder, obsessive-compulsive disorder, posttraumatic stress disorder, attention deficit hyperactivity disorder, posttraumatic stress disorder, attention deficit hyperactivity disorder, attention d
addiction, are known to relate to the functioning of the brain.[125][129][178] Treatment for mental disorders may include psychotherapy, psychiatry, social intervention and personal recovery work or cognitive behavioural therapy; the underlying issues and associated prognoses vary significantly between individuals.[179]Epileptic seizures are
thought to relate to abnormal electrical activity.[180] Seizure activity can manifest as absence of consciousness, focal effects such as limb movement or impediments of seizures that have not terminated within five minutes.[181] Seizures have a large number of
causes, however many seizures occur without a definitive cause being found. In a person with epilepsy, risk factors for further seizures may be assessed using blood tests, EEG and various medical imaging techniques based on the medical history and medical examination
findings.[180] In addition to treating an underlying cause and reducing exposure to risk factors, anticonvulsant medications can play a role in preventing further seizures.[180] Some brain disorders, such as TaySachs disease,[182] are congenital and linked to genetic and chromosomal mutations.[183] A rare group of congenital cephalic disorders
known as lissencephaly is characterised by the lack of, or inadequacy of, cortical folding.[184] Normal development of the brain can be affected during pregnancy by nutritional deficiencies, [185] teratogens, [186] infectious diseases, [187] and by the use of recreational drugs, including alcohol (which may result in fetal alcohol spectrum disorders).
[185][188]Most cerebral arteriovenous malformations are congenital, these tangled networks of blood vessels may remain without symptoms but at their worst may rupture and cause intracranial hemorrhaging. [189]Main article: StrokeCT scan of a cerebral hemorrhaging an intraparenchymal bleed (bottom arrow) with surrounding edema
(top arrow) A stroke is a decrease in blood supply to an area of the brain causing cell death and brain injury. This can lead to a wide range of symptoms, including with speaking and finding words or forming sentences). [190] Symptoms relate to the function of the
affected area of the brain and can point to the likely site and cause of the stroke. Difficulties with movement, speech, or sight usually relate to the brainstem or cerebellum.[191]Most strokes result from loss of blood
supply, typically because of an embolus, rupture of a fatty plaque causing thrombus, or narrowing of small arteries. Strokes in which symptoms resolve within 24 hours.[192] Investigation into the stroke will involve a medical examination (including a
neurological examination) and the taking of a medical history, focusing on the duration of the symptoms and risk factors (including high blood pressure, atrial fibrillation, and smoking).[193] Further investigation is needed in younger patients.[194] An ECG and biotelemetry may be conducted to identify atrial fibrillation; an ultrasound can investigate
narrowing of the carotid arteries; an echocardiogram can be used to look for clots within the heart, diseases of the heart valves or the presence of a patent foramen ovale. [194] Some treatments for stroke are time-critical. These include clot dissolution
or surgical removal of a clot for ischaemic strokes, and decompression for haemorrhagic stroke involves expedited investigate for a haemorrhagic stroke and a CT or MR angiogram to evaluate arteries that supply the brain.[194]
MRI scans, not as widely available, may be able to demonstrate the affected area of the brain more accurately, particularly with ischaemic stroke, a person may be admitted to a stroke unit, and treatments may be directed as preventing future strokes, including ongoing anticoagulation (such as aspirin or
clopidogrel), antihypertensives, and lipid-lowering drugs.[195] A multidisciplinary team including speech pathologists, physiotherapists, occupational therapists, and psychologists plays a large role in supporting a person affected by a stroke and their rehabilitation.[198][194] A history of stroke increases the risk of developing dementia by around
70%, and recent stroke increases the risk by around 120%.[199]Main article: Brain death Brain death refers to an irreversible total loss of brain function.[200][201] This is characterised by coma, loss of reflexes, and apnoea, [200] however, the declaration of brain death varies geographically and is not always accepted.[201] In some countries there is
also a defined syndrome of brainstem death [202] Declaration of brain death can have profound implications as the declaration under the principle of medical futility, will be associated with the withdrawal of life support [203] and as those with brain death often have organs suitable for organ donation. [201][204] The process is often made more
difficult by poor communication with patients' families.[205]When brain death is suspected, reversible differential diagnoses such as, electrolyte, neurological and drug-related cognitive suppression need to be excluded.[200][203] Testing for reflexes[b] can be of help in the decision, as can the absence of response and breathing.[203] Clinical
observations, including a total lack of responsiveness, a known diagnosis, and neural imaging evidence, may all play a role in the decision to pronounce brain development. [206]
Cultural differences and their relation to brain development and structure are researched in different fields. [207] Main articles: Cognition and MindThe skull of Phineas Gage, with the path of the iron rod that passed through it without killing him, but altering his cognition. The case helped to convince people that mental functions were localised in the
brain.[208] The philosophy of the mind studies such issues as the problem of understanding consciousness and the mindbody problem. The relationship between the brain and the mind studies such issues as the problem of understanding consciousness and the mindbody problem. The relationship between the brain and the mind studies such issues as the problem of understanding consciousness and the mindbody problem.
be implemented by physical structures such as neurons and synapses, or by any other type of physical mechanism. This difficulty was expressed by Gottfried Leibniz in the analogy known as Leibniz's Mill:One is obliged to admit that perception and what depends upon it is inexplicable on mechanical principles, that is, by figures and motions. In
imagining that there is a machine whose construction would enable it to think, to sense, and to have perception, one could conceive it enlarged while retaining the same proportions, so that one could enable it to think, to sense, and to have perception, one should, when visiting within it, find only parts pushing one another, and never anything by
which to explain a perception. Leibniz, Monadology[209]Doubt about the possibility of a mechanistic explanation of thought drove Ren Descartes, and most other philosophers along with him, to dualism: the belief that the mind is to some degree independent of the brain. [210] There has always, however, been a strong argument in the opposite
direction. There is clear empirical evidence that physical manipulations of, or injuries to, the brain (for example by drugs or by lesions, respectively) can affect the mind in potent and intimate ways. [211][212] In the 19th century, the case of Phineas Gage, a railway worker who was injuried by a stout iron rod passing through his brain, convinced both
researchers and the public that cognitive functions were localised in the brain. [208] Following this line of thinking, a large body of empirical evidence for a close relationship between brain activity and mental activity has led most neuroscientists and contemporary philosophers to be materialists, believing that mental phenomena are ultimately the
result of, or reducible to, physical phenomena. [213] Main article: Brain sizeThe size of the brain and a person's intelligence are not strongly related. [214] Studies tend to indicate small to moderate correlations (averaging around 0.3 to 0.4) between brain volume and IQ. [215] The most consistent associations are observed within the frontal, temporal,
and parietal lobes, the hippocampi, and the cerebellum, but these only account for a relatively small amount of variance in IQ, which itself has only a partial relationship to general intelligence and real-world performance. [216][217]Other animals, including whales and elephants, have larger brains than humans. However, when the brain-to-body mass
ratio is taken into account, the human brain is almost twice as large as that of a bottlenose dolphin, and three times as large as that of a chimpanzee. However, a high ratio does not of itself demonstrate intelligence: very small animals have high ratio does not of itself demonstrate intelligence in an 1883
chartEarlier ideas about the relative importance of the different organs of the human body sometimes emphasised the heart.[219]Modern Western popular conceptions, in contrast, have placed increasing focus on the brain. These include both ancient and modern myths. It is
not true (for example) that neurons are not replaced after the age of two; nor that normal humans use only ten per cent of the brain by suggesting that functions are completely specific to one side of the brain or the other. Akio Mori coined the term "game brain" for the
unreliably supported theory that spending long periods playing video games harmed the brain's pre-frontal region, and impaired the expression of emotion and creativity. [222] Historically, particularly in the early-19th century, the brain featured in popular culture through phrenology, a pseudoscience that assigned personality attributes to different
regions of the cortex. The cortex remains important in popular culture as covered in books and satire. [223][224]The human brain can feature in science fiction, with themes such as brain transplants and cyborgs (beings with features like partly artificial brains). [225] The 1942 science-fiction book (adapted three times for the cinema) Donovan's Brain
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tells the tale of an isolated brain kept alive in vitro, gradually taking over the personality of the book's protagonist. [226]Main article: History of neuroscienceHieroglyph for the word "brain" (c.1700 BC)The Edwin Smith Papyrus, an ancient Egyptian medical treatise written in the 17th century BC, contains the earliest recorded reference to the brain. The hieroglyph for brain, occurring eight times in this papyrus, describes the symptoms, diagnosis, and prognosis of two traumatic injuries to the head. The papyrus mentions the external surface of the brain, the effects of injury (including seizures and aphasia), the meninges, and cerebrospinal fluid. [227][228]In the fifth century BC, Alcmaeon of Croton in Magna Grecia, first considered the brain to be the seat of intelligence. Aristotle, in his biology initially believed the heart to be the seat of intelligence, and saw the brain as a cooling mechanism for the blood. He reasoned that humans are more rational than the beasts because, among other reasons, they have a larger brain to cool their hot-bloodedness. [229] Aristotle did describe the meninges and distinguished between the cerebrum and cerebellum.

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[230]Herophilus of Chalcedon in the fourth and third centuries BC distinguished the cerebrum and the cerebru
their discoveries had to be re-discovered a millennium after their deaths.[228] Anatomist physician Galen in the second century AD, during the time of the Roman Empire, dissected the brain, it must control the muscles, while as the cerebrum was
soft, it must be where the senses were processed. Galen further theorised that the brain functioned by movement of animal spirits through the ventricles. [228][229]In 2025, scientists reported the discovery of a preserved human brain from the eruption of Mount Vesuvius in 79 AD. A man in Herculaneum was caught in a pyroclastic flow, and the
extremely high temperature caused the vitrification of his brain, turning it into glass and resulting in "a perfect state of preservation of the brain and its microstructures." [231] It appears to have been the only known case of a vitrified human brain. [231] It appears to have been the only known case of a vitrified human brain.
fabricaOne of Leonardo da Vinci's sketches of the human skullIn 1316, Mondino de Luzzi's Anathomia began the modern study of brain anatomy.[233]Niccol Massa discovered in 1536 that the ventricles were filled with fluid.[234] Archangelo Piccolomini of Rome was the first to distinguish between the cerebrum and cerebral cortex.[235] In 1543
Andreas Vesalius published his seven-volume De humani corporis fabrica. [235][236][237] The seventh book covered the brain and eye, with detailed images of the ventricles, cranial nerves, pituitary gland, meninges, structures of the eye, the vascular supply to the brain and spinal cord, and an image of the peripheral nerves. [238] Vesalius rejected
the common belief that the ventricles were responsible for brain function, arguing that many animals have a similar ventricular system to humans, but no true intelligence. [235]Ren Descartes proposed the theory of dualism to tackle the issue of the brain's relation to the mind. He suggested that the pineal gland was where the mind interacted with
the body, serving as the seat of the soul and as the connection through which animal spirits passed from the blood into the brain. [234] This dualism likely provided impetus for later anatomists to further explore the relationship between the anatomists and anatomist the anatomist and the anatomist the anatomist and the anatomist the anatomist and t
study of neurology and brain science. He wrote Cerebri Anatomy of the brain)[c] in 1664, followed by Cerebral Pathology in 1667. In these he described the structure of the cerebral hemispheres, the brainstem, and the cranial nerves, studied its blood supply; and proposed functions associated with
different areas of the brain.[235] The circle of Willis was named after his investigations into the blood supply of the brain from the body when examining it, and rejected the commonly held view that the cortex only consisted of blood vessels, and the view of the last two
millennia that the cortex was only incidentally important. [235] In the middle of 19th century Emil du Bois-Reymond and Hermann von Helmholtz were able to use a galvanometer to show that electrical impulses passed at measurable speeds along nerves, refuting the view of their teacher Johannes Peter Miler that the nerve impulse was a vital function
that could not be measured.[241][242][242] Richard Caton in 1875 demonstrated electrical impulses in the cerebral hemispheres of rabbits and monkeys.[244] In the 1820s, Jean Pierre Flourens pioneered the experimental method of damaging specific parts of animal brains describing the effects on movement and behavior.[245]Further information:
NeuropsychiatryDrawing by Camillo Golgi of vertical section of rabbit hippocampus, from his "Sulla fina anatomia degli organi centrali del sistema nervoso", 1885Drawing of cells in chick cerebellum by Santiago Ramn y Cajal, from "Estructura de los centros nerviosos de las aves", Madrid, 1905Studies of the brain became more sophisticated with the
use of the microscope and the development of a silver staining method by Camillo Golgi during the 1880s. This was able to show the intricate structures of single neurons. [246] This was used by Santiago Ramn y Cajal and led to the formation of the neuron doctrine, the then revolutionary hypothesis that the neuron is the functional unit of the brain.
He used microscopy to uncover many cell types, and proposed functions for the cells he saw.[246] For this, Golgi and Cajal are considered the founders of twentieth century neuroscience, both sharing the Nobel prize in 1906 work The Integrative
Action of the Nervous System examining the function of reflexes, evolutionary development of the nervous system, functional specialisation of the term enchanted loom as a metaphor for the brain. John Farquhar Fulton, founded the Journal of
Neurophysiology and published the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the twentieth century began to be recognised as a distinct unified academic discipline, with David Rioch, Francis O. Schmitt, and Stephen Kuffler playing critical roles in establishing the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the twentieth century began to be recognised as a distinct unified academic discipline, with David Rioch, Francis O. Schmitt, and Stephen Kuffler playing critical roles in establishing the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook on the physiology of the nervous system during 1938.[248] Neuroscience during the first comprehensive textbook of the nervous system during 1938.[248] Neuroscience during 1938 Neuro
originated the integration of basic anatomical and physiological research with clinical psychiatry at the Walter Reed Army Institute of Research, starting in the 1950s. [250] During the same period, Schmitt established the Neuroscience Research, starting in the 1950s. [250] During the same period, Schmitt established the Neuroscience Research, starting in the 1950s. [250] During the same period, Schmitt established the Neuroscience Research Program, an inter-university and international organisation, bringing together biology, medicine,
psychological and behavioural sciences. The word neuroscience itself arises from this program.[251] Paul Broca associated regions of the brain with specific functions, in particular language in Broca's area, following work on brain-damaged patients.[252] John Hughlings Jackson described the function of the motor cortex by watching the progression
of epileptic seizures through the body. Carl Wernicke described a region associated with language comprehension and production. Korbinian Brodmann divided regions of the brain based on the appearance of cells.[252] By 1950, Sherrington, Papez, and MacLean had identified many of the brainstem and limbic system functions.[253][254] The
capacity of the brain to re-organise and change with age, and a recognised critical development period, were attributed to neuroplasticity, pioneered by Margaret Kennard, who experimented on monkeys during the 1930-40s. [255] Harvey Cushing (18691939) is recognised as the first proficient brain surgeon in the world. [256] In 1937, Walter Dandy
began the practice of vascular neurosurgery by performing the first surgical clipping of an intracranial aneurysm. [257] most notably a six-layered cerebral cortex and a set
of associated structures, [260] including the hippocampus and amygdala. [261] The cortex is proportionally larger in humans than in many other mammals such as the rat and the cat. [263] As a primate brain, the human brain has a much larger cerebral cortex,
in proportion to body size, than most mammals, [261] and a highly developed visual system. [264][265] As a hominid brain, the human brain is substantially enlarged even in comparison to the brain of a typical monkey. The sequence of human evolution from Australopithecus (four million years ago) to Homo sapiens (modern humans) was marked by a
steady increase in brain size. [266] [267] As brain size increased, this altered the skull, [268] from about 600 cm3 in Homo neanderthalensis. [269] Differences in DNA, gene expression, and geneenvironment interactions help explain the differences between the function of the human
brain and other primates.[270]Philosophy portalPsychology portalOutline of the human brainOutline of neuroscienceBrain health and pollutionCerebral atrophyCortical spreading depressionEvolution of human intelligenceLarge-scale brain networksSuperficial veins of the brain^ "Encephalo- Etymology". Online Etymology Dictionary. Archived from
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exits along paravascular spaces of draining veins. ... In addition to A clearance, the glymphatic system may be involved in the removal of other interstitial solutes and metabolites. By measuring the lactate concentration in the brains and cervical lymph nodes of awake and sleeping mice, Lundgaard et al. (2017) demonstrated that lactate can exit the
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interference suppression).... Functional neuroimaging in humans demonstrates activation of the prefrontal cortex and caudate nucleus (part of the dorsal striatum) in tasks that demand inhibitory control of behavior.... Early results with structural MRI show a thinner cerebral cortex, across much of the cerebrum, in ADHD subjects compared with age
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consumes ~60% of the blood glucose used in the sedentary, fasted person.... The amount of glucose in the blood is preserved at the expense of glycogen in muscle. Carbohydrate oxidation by the working muscle can go up by ~10-fold with
 exercise, and yet after 1h, blood glucose is maintained at \sim4g.... It is now well established that both insulin and exercise cause translocation, [muscle glucose uptake (MGU)] is controlled differently with exercise and insulin. Contraction-stimulated
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accessory nerve and hypoglossal nerves.[38]^ Including the vestibulo-ocular reflex, corneal reflex, corneal reflex, gag reflex and dilation of the pupils in response to light,[203]^ Illustrated by architect Christopher Wren[235]Wikimedia Commons has media related to Human brain. Brain facts and figures Washington.eduHuman brain National Geographic Retrieved
from "2Form of computer-aided engineeringThis article is about computer modeling within an artistic medium. For scientific usage, see Computer simulation. Three-dimensional (3D)computer graphicsFundamentalsModelingScanningRenderingPrintingPrimary uses3D modelsComputer-aided designGraphic designG
effectsVisualizationVirtual engineeringVirtual realityVirtual cinematographyRelated topicsComputer-generated imagery (CGI)AnimationComputerskeletal3D displayWire-frame modelTexture mappingMotion captureCrowd simulationGlobal illuminationVolume renderingvirtual realityVirtual cinematographyRelated topicsComputer graphics, 3D modeling is the process of developing a
mathematical coordinate-based representation of a surface of an object (inanimate or living) in three dimensions via specialized software by manipulating edges, vertices, and polygons in a simulated 3D space, connected by various geometric
entities such as triangles, lines, curved surfaces, etc.[4] Being a collection of data (points and other information), 3D models can be created manually, algorithmically (procedural modeling), or by scanning.[5][6] Their surfaces may be further defined with texture mapping. See also: Environment artistThe product is called a 3D model, while someone
who works with 3D models may be referred to as a 3D artist or a 3D modeler. A 3D model can also be displayed as a two-dimensional image through a process called 3D rendering or used in a computer simulation of physical phenomena. B models may be created automatically or manually. The manual modeling process of preparing geometric data
for 3D computer graphics is similar to plastic arts such as sculpting. The 3D model can be physically created using 3D printing devices that form 2D layers of the model with three-dimensional material, one layer at a time. Without a 3D model, a 3D print is not possible.3D modeling software is a class of 3D computer graphics software used to produce
3D models. Individual programs of this class are called modeling applications. [7] Three-dimensional model of a spectrograph[8] Rotating 3D video-game models are now widely used anywhere in 3D graphics and CAD but their history
predates the widespread use of 3D graphics onpersonal computers (19] In the past, manycomputer gamesused pre-rendered images of 3D models assprites before computers could render them in real-time. The designer can then see the model in various directions and views, this can help the designer see if the object is created as intended to compared
to their original vision. Seeing the design this way can help the designer or company figure out changes or improvements needed to the product.[10]A modern render of the most common models used in 3D graphics education. Almost all 3D models can be
divided into two categories: Solid These models define the volume of the object they represent (like a rock). Solid models are mostly used for engineering and medical simulations, and are usually built with constructive solid geometry held or boundary. These models represent the surface, i.e., the boundary of the object, not its volume (like an
infinitesimally thin eggshell). Almost all visual models used in games and film are shell models. Solid and shell models used in games and film are shell models used in games and film are shell models. Solid and shell models used in games and film are shell models used in games and film are shell models.
and reality. Shell models must be manifold (having no holes or cracks in the shell) to be meaningful as a real object. For example, in a shell model of a cube, all six sides must be connected with no gaps in the edges or the corners. Polygonal meshes (and to a lesser extent, subdivision surfaces) are by far the most common representation. Level sets are
a useful representation for deforming surfaces that undergo many topological changes, such as fluids. The process of transforming representation of a sphere is called tessellation. This step is used in polygon-based rendering,
where objects are broken down from abstract representations ("primitives") such as spheres, cones etc., to so-called meshes, which are nets of interconnected triangles. Meshes of triangles (instead of e.g., squares) are popular as they have proven to be easy to rasterize (the surface described by each triangle is planar, so the projection is always
convex).[11] Polygon representations are not used in all rendering techniques, and in these cases the tessellation step is not included in the transition from abstract representation to rendered scene. There are three popular ways to represent a model: Polygonal modeling Points in 3D space, called vertices, are connected by line segments to form a
polygon mesh. The vast majority of 3D models today are built as textured polygons are planar and can only approximate curved surfaces using many polygons. Curve modeling Surfaces are defined by curves, which are influenced by weighted
control points. The curve follows (but does not necessarily interpolate) the points. Increasing the weight for a point pulls the curve closer to that point. Curve types include nonuniform rational B-spline (NURBS), splines, patches, and geometric primitivesDigital sculpting There are three types of digital sculpting: Displacement, which is the most
widely used among applications at this moment, uses a dense model (often generated by subdivision surfaces of a polygon control mesh) and stores new locations. Volumetric, loosely based on voxels, has similar capabilities as displacement but does not suffer from
polygon stretching when there are not enough polygons in a region to achieve a deformation. Dynamic tessellation, which is similar to voxel, divides the surface and allow finer details. These methods allow for artistic exploration as the model has new topology created over it once the models form and
possibly details have been sculpted. The new mesh usually has the original high-resolution mesh information transferred into displacement data or normal map data if it is for a game engine. A 3D fantasy fish composed of organic surfaces generated using LAI4D. The modeling stage consists of shaping individual objects that are later used in the scene
There are a number of modeling techniques, including: Constructive solid geometry Implicit surfaces Subdivision su
component (Shaper, Lofter in 3ds Max) or some scene description language (as in POV-Ray). In some cases, there is no strict distinction between these phases; in such cases, modeling is just part of the scene creation process (this is the case, for example, with Caligari trueSpace and Realsoft 3D).3D models can also be created using the technique of
Photogrammetry with dedicated programs such as RealityCapture, Metashape and 3DF Zephyr. Cleanup and further processing can be performed with applications such as MeshLab, the GigaMesh Software Framework, netfabb or MeshMixer. Photogrammetry creates models using algorithms to interpret the shape and texture of real-world objects
and environments based on photographs taken from many angles of the subject. Complex materials such as blowing sand, clouds, and liquid sprays are modeled with particle systems, and are a mass of 3D coordinates which have either points, polygons, texture splats or sprites assigned to them. Main article: List of 3D modeling software There are a
variety of 3D modeling programs that can be used in the industries of engineering, interior design, film and others. Each 3D modeling software has specific capabilities and can be utilized to fulfill demands for the industry. Many programs include export options to form a g-code, applicable to additive or subtractive manufacturing machinery. G-code
(computer numerical control) works with automated technology to form a real-world rendition of 3D models. This code is a specific set of instructions to carry out steps of a product's manufacturing. [12] Main article: Virtual actor The first widely available commercial application of human virtual models appeared in 1998 on the Lands' End web site. The
human virtual models were created by the company My Virtual Mode Inc. and enabled users to create a model of themselves and try on 3D clothing. There are several modern programs that allow for the creation of virtual human models (Poser being one example). Dynamic 3D clothing model made in Marvelous DesignerThe development of cloth
simulation software such as Marvelous Designer, CLO3D and Optitex, has enabled artists and fashion designers to model dynamic 3D clothing is used for virtual fashion catalogs, as well as for dressing 3D characters for video games, 3D animation movies, for digital doubles in movies, [14] as a creation tool for
digital fashion brands, as well as for making clothes for avatars in virtual worlds such as SecondLife.3D photorealistic effects are often achieved without wire-frame modeling and are sometimes indistinguishable in the final form. Some graphic art software includes filters that can be applied to 2D vector graphics or 2D raster graphics on transparent
layers. Advantages of wireframe 3D modeling over exclusively 2D methods include: Flexibility, ability to change angles or animate images with quicker rendering photorealism, less chance of human error
in misplacing, overdoing, or forgetting to include a visual effect. Disadvantages compared to 2D photorealistic effects may be achieved with special rendering filters included in the 3D modeling software. For the best of both
worlds, some artists use a combination of 3D modeling followed by editing the 2D computer-rendered images from the 3D models (as well as 3D-related content, such as textures, scripts, etc.) existseither for individual models or large collections. Several online marketplaces for 3D content allow individual artists to sell
content that they have created, including TurboSquid, MyMiniFactory, Sketchfab, CGTrader, and Cults. Often, the artists' goal is to get additional value out of assets they have previously created for projects. By doing so, artists can earn more money out of their old content, and companies can save money by buying pre-made models instead of paying
an employee to create one from scratch. These marketplaces typically split the sale between themselves and the artist retains ownership of the 3d model while the customer only buys the right to use and present the model. Some artists
sell their products directly in their products directly in their own stores, offering their products at a lower price by not using intermediaries. The architecture, engineering and construction (AEC) industry, is the biggest market for 3D modeling, with an estimated value of $12.13 billion by 2028. [15] This is due to the increasing adoption of 3D modeling in the AEC industry,
which helps to improve design accuracy, reduce errors and omissions and facilitate collaboration among project stakeholders.[16][17]Over the last several years numerous marketplaces are a combination of models sharing sites, with or without a
built in e-com capability. Some of those platforms also offer 3D printing services on demand, software for model rendering and dynamic viewing of items. Main articles: 3D printing services on demand, software for model rendering and dynamic viewing of items. Main articles: 3D printing services on demand, software for model rendering and dynamic viewing of items. Main articles: 3D printing articles: 3D printing services on demand, software for model rendering and dynamic viewing of items.
successive layers of material.[18] Objects can be created without the need for complex and expensive molds or assembly of multiple parts. 3D printing allows ideas to be prototyped and tested without having to go through a more time-consuming production process.[18][19]3D models can be purchased from online markets and printed by individuals
or companies using commercially available 3D printers, enabling the home-production of objects such as spare parts and even medical equipment. [20][21]Steps of forensic facial reconstruction of a mummy made in Blender by the Brazilian 3D designer Ccero Moraes 3D modeling is used in many industries. [22]The medical industry uses detailed
models of organs created from multiple two-dimensional image slices from an MRI or CT scan. [23] Other scientific fields can use 3D models to visualize and communicate information such as models for computer-generated characters and objects in animated and real-life motion
pictures. Similarly, the video game industry uses 3D models as assets for computer and video games. The source of the geometry for the shape of an object that has been reverse engineered or copied using a 3D shape digitizer or scanner; or mathematical data
based on a numerical description or calculation of the object. [18] The architecture industry uses 3D models to demonstrate proposed buildings and landscapes in lieu of traditional, physical architecture, engineering, and construction.
[25][26]Archeologists create 3D models of cultural heritage items for research and visualization. [27][28] For example, the International Institute of MetaNumismatic artifacts. [29]In recent decades, the earth science community has started to
construct 3D geological models as a standard practice. 3D models are also used in constructing digital representations of mechanical parts before they are manufactured. Using CAD- and CAM-related software, an engineer can test the functionality of assemblies of parts then use the same data to create toolpaths for CNC machining or 3D printing. 3D
modeling is used in industrial design, wherein products are 3D modeled [30] before representing them to the clients. In media and event industries, 3D modeling is used in stage and set design. [31] The OWL 2 translation of the vocabulary of X3D can be used to provide semantic descriptions for 3D models, which is suitable for indexing and retrieval of
3D models by features such as geometry, dimensions, material, texture, diffuse reflection, transmission spectra, transparency, reflectivity, opalescence, glazes, varnishes and enamels (as opposed to unstructured textual descriptions or 2.5D virtual museums and exhibitions using Google Street View on Google Arts & Culture, for example).[32] The
RDF representation of 3D models can be used in reasoning, which enables intelligent 3D applications which, for example, can automatically compare two 3D models by volume.[33]List of 3D models by volume.[33]List of 3D models can be used in reasoning, which enables intelligent 3D applications which, for example, can automatically compare two 3D models by volume.[33]List of 3D models by volume.[33]List of 3D models can be used in reasoning, which enables intelligent 3D applications which, for example, can automatically compare two 3D models can be used in reasoning.
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scanningAdditive manufacturing file formatBuilding information modelingCG artistCloth modelingComputer facial animationCornell boxDigital geometryEdge loopEnvironment artistGeological modelingComputer facial animationCornell boxDigital geometryEdge loopEnvironment artistGeological modelingRay tracing (graphics)Scaling (geometry)SIGGRAPHStanford bunnyTriangle meshUtah teapotVoxelB-rep^ "What is 3D Modeling & What's It Used For?". Concept Art Empire. 2018-04-27. Retrieved 2021-07-14.^ "What is 3D Modeling is Used Today". Tops. 2020-04-27. Retrieved 2021-07-14. 2021-07-14. Slick, Justin (2020-09-24). "What Is 3D Modeling?". Lifewire. Retrieved 2021-07-14. Tredinnick, Ross; Anderson, Lee; Ries, Brian; Interrante, Victoria (2006). "A Tablet Based Immersive Architectural Design Tool" (PDF). Synthetic Landscapes: Proceedings of the 25th Annual Conference of the Association for Computer-Aided Design in Architecture (ACADIA). ACADIA. pp.328341. doi:10.52842/conf.acadia.2006.328. 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View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500) Applet (links | edit) Global illumination (links | edit) Global illumination (links | edit) Global illumination (links | edit) Graphic design (links | edit) Hierarchy (links | edit) International Space Station (links | edit) Virginia-class submarine (li editor (links | edit)Printing (links | edit)Donkey Kong (character) (links | edit)Underground hard-rock mining | edit)POV-Ray (links | edit)Animator (links teapot (links | edit)Tradesperson (links | edit)Social class in the United States (links | edit)Cornell box (links | edit)Cornell box (links | edit)Distance fog (links | edit)Distance

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