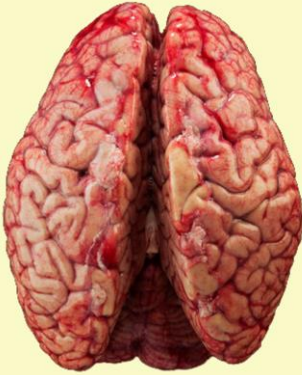


The Human Brain



The Brain—is wider than the Sky—
For—put them side by side—
The one the other will include
With ease—and You—beside—

The Brain is deeper than the sea—
For—hold them—Blue to Blue—
The one the other will absorb—
As Sponges—Buckets—do—

The Brain is just the weight of God—
For—Lift them—Pound for Pound—
And they will differ—if they do—
As Syllable from Sound—

Emily Dickinson, 1863
(read by Becky Miller)

Welcome to the Human Brain! It only weighs about 3 pounds (1400 gm). Yet it contains about 80 billion neurons. With over 100 trillion connections between them. In some way, we know not yet how, it embodies all our thinking and makes it possible for us to find meaning in the sounds we hear. And one day understand the universe.

Dickinson's poem is every bit as complex as the brain – it also has a surface structure and a deep meaning. And many unanswered questions. What is the weight of God? It likely has to do with the meaning of the word 'weight,' which includes ideas of importance and of meaning. The divinity creates a universe in which sound occurs but the brain can understand some sounds as syllables.

Contact Information**Terry Picton, Background:**

Medicine (neurology, neuro-physiology)
Research (hearing, cognition)

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<http://creatureandcreator.ca/>

http://creatureandcreator.ca/?page_id=1017



The Anatomy Lesson of Doctor Deijman

Rembrandt van Rijn, 1656

Who am I? I am old like you. I have a medical background but I have not practiced for almost thirty years and I would not trust my own health advice. I have studied hearing. It is therefore perhaps fitting that I now have a hearing loss and hearing aids. Since I have also studied cognition. I am now waiting for my dementia to catch up with me.

I am happy to entertain questions, though I may need the help of my wife and the class liaison in understanding them.

Forgive me if I sometimes answer a different question from the one you asked,. Even so the answer might still be interesting.

I would be happy to receive emails, and I will try to answer questions sent through email.

The illustration is *The Anatomy Lesson of Dr. Deijman* (pronunciation: dee-eye-man). It is only a fragment of a larger painting that was severely damaged in a fire. The professor demonstrates the membranes surrounding the brain of the thief Joris Fonteijn, who had been executed by hanging.

The lost upper part of the original painting showed the professor dissecting the brain and an assembly of students observing. The fellow on the left is a simple assistant. He is holding the calvarium – the top of the skull that has been removed. I am not an expert in many of the topics I shall be presenting. I am an attendant lord, one that will do to start you thinking but may not have all the answers.

I have a webpage. Though initially started for other reasons, it will allow you to download course notes.

Who are you?

- (i) What kind of educational background – science, humanities?
- (ii) What level of education – high school, university?
- (iii) Experience of brain/mind disorders – self, family?

What do you want to know?

- (i) How the neurons work – synapses, transmitters?
- (ii) How the brain processes information – language, memory?
- (iii) What and why is consciousness?
- (iv) How brain diseases occur?
- (v) What the future holds?

Email: terry.picton@gmail.com

All I know about you is that there are at least 50 of you and that you are all at least 50.

My guess is that only half of you have some science in your educational background, that most of you have been to university, and that almost all of you have experienced brain disorders in yourselves or your family.

I shall be teaching at the level of an undergraduate university course.

I have made assumptions of what you might want to learn in this course.

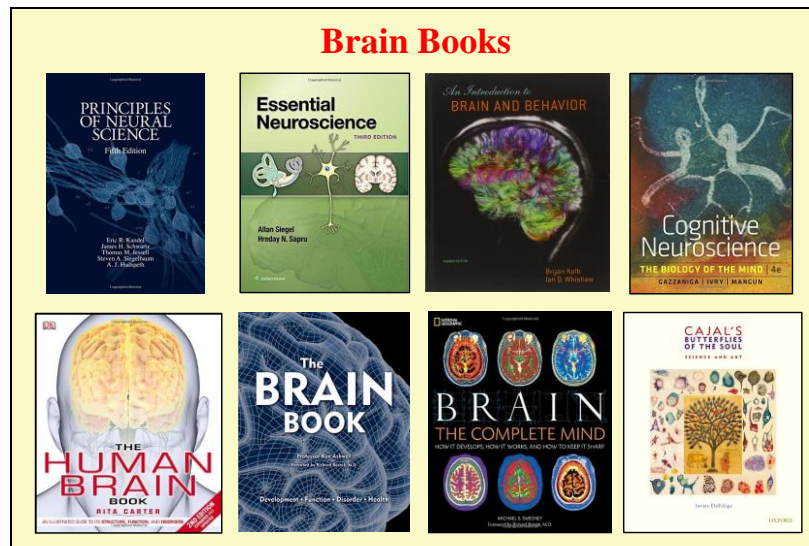
Please let me know if you wish other topics to be considered, and I shall try to adapt.

However, the course is relatively short and I shall not be able to cover everything we know about the brain.

In eight sessions you will get to know much about the brain. However, I have left a lot out. Also my own understanding of the brain is far from complete.

Occasionally for want of time I may not cover everything in the notes.

You may not understand everything that I present. Sometimes you might want to let the information just wash over you. Some of the information will stick and then it all may become clear a few slides later.



You do not need a textbook. However, some of you may be interested.

Some books (with approximate prices on Amazon in CAD):

The main textbooks are in the upper line

Basic: Kandel – 150

Medical: Siegel – 90

Neuropsychology: Kolb – 250

Cognitive: Gazzaniga – 175

The following three books are oriented to the general reader:

Carter – 60

Ashwell – 35

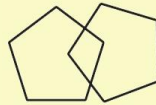
Sweeney – 35

This is a book of pictures:

Cajal – 90

Mini Mental Status Exam

- (i) Orientation to time (5 points)
- (ii) Orientation to place (5 points)
- (iii) Registration (3 points)
- (iv) Attention – subtract 7 from 100 (5 points)
- (v) Recall (3 points)
- (vi) Language – naming (2 points), repetition (1 point), following commands (3 points), reading (1 point), writing (1 point)
- (vii) Spatial – draw the following figure (1 point)



Normal: 24-30; Mild Impairment: 18-23; Severe Impairment 0-17

LIFE courses are different.

In this course, we shall have our final exam at the very beginning of the course.

One of the major fears that comes with growing old is the fear of becoming demented. So to dispel that fear we shall go through the Mini Mental Status Exam

Time – year season month date day

Place – country province city building floor

Registration – apple penny table

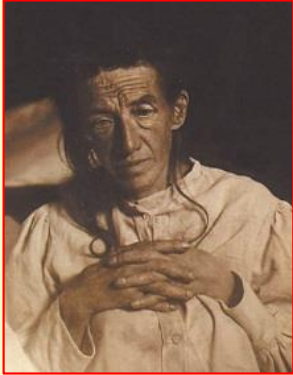
Attention – 100 93 86 79 72 65

Recall three words after an interval – apple, penny, table

Language: name watch, pencil; repeat “no ifs ands or buts”; raise your hand, close your eyes, wave; reading and writing (a simple sentence) .

Spatial

**Ich habe mich
sozusagen verloren**

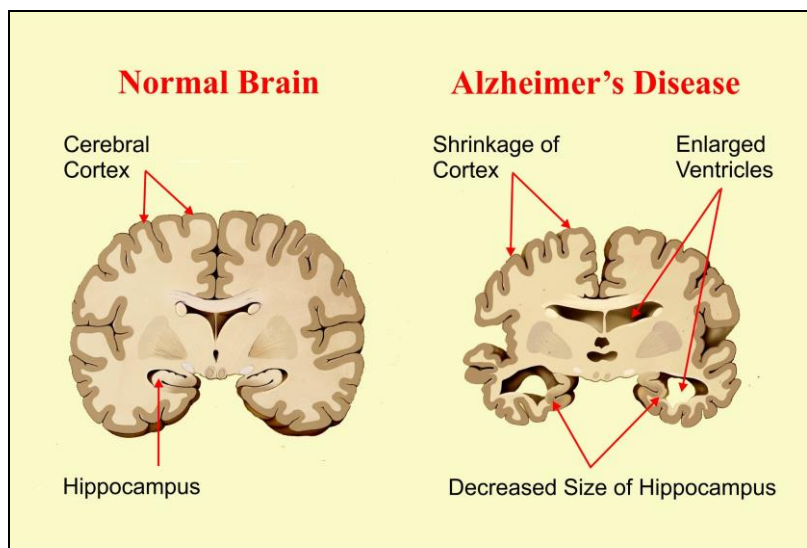


Auguste Deter (1850-1906)

What is your name?
Auguste.
Family name?
Auguste.
What is your husband's name?
.....I believe ... Auguste.
Your husband?
Oh, so!
How old are you?
Fifty-one.
Where do you live?
Oh, you have been to our place
Are you married?
Oh, I am so confused.
Where are you right now?
Here and everywhere, here and now,
you must not think badly of me.
Where are you at the moment?
We will live there.

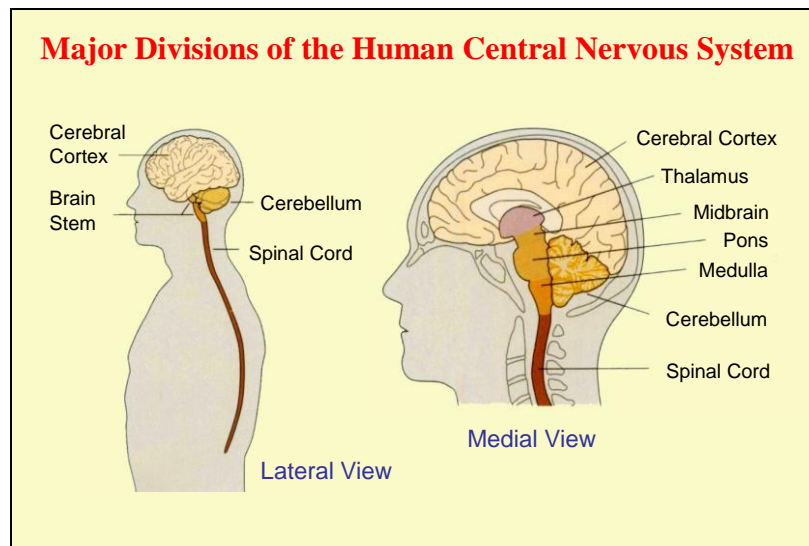
This is not you. The German translates as “I have, you might say, mislaid myself.” Syntactically correct. Semantically devastating.

Auguste Deter was the first patient described by Alois Alzheimer in 1901. Amazingly the original notes from her clinical examination were preserved in the hospital records. As was her photograph.



Major pathological changes of Alzheimer's Disease. These are slices of the brain cut in the coronal plane.

The hippocampus is an area of the brain that is essential for laying down and recalling memories. The main presenting symptom of dementia is a loss of memory.



To understand how the brain works we need to learn a little anatomy.

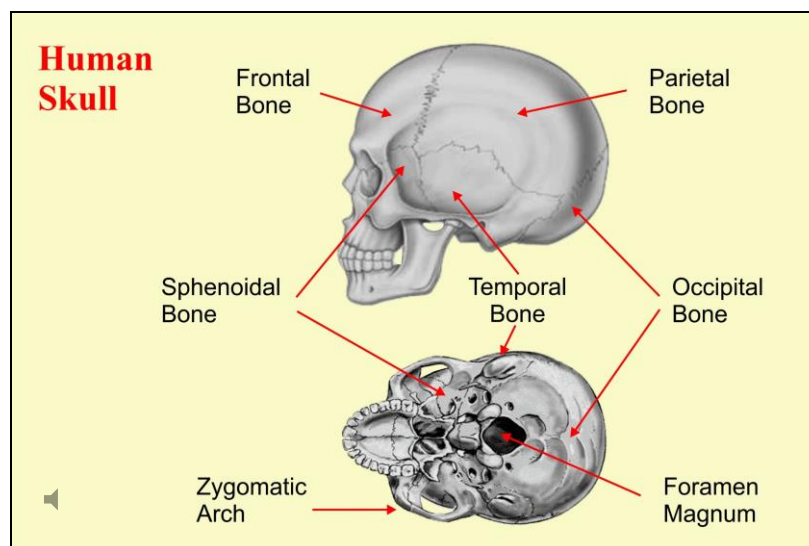
It takes effort to learn the names but we must know where things are before we figure out what they do or how they do it.

The nervous system is (like Gaul) in three parts divided – the brain, spinal cord and peripheral nervous system.

The brain itself also has three main parts – cerebrum, cerebellum (big brain and little brain) and the brain stem.

And the brain stem has three parts – midbrain, pons, medulla

The God of evolution was partial to the number three.



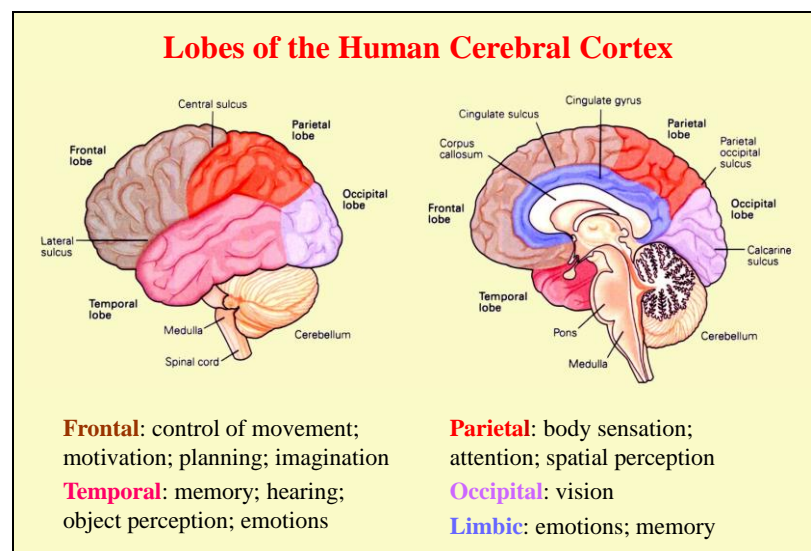
Alas, poor Yorick! I knew him, Horatio, a fellow of infinite jest, of most excellent fancy. He hath borne me on his back a thousand times, and now, how abhorred in my imagination it is! My gorge rises at it. Here hung those lips that I have kissed I know not how oft. —Where be your

gibes now? Your gambols? Your songs? Your flashes of merriment that were wont to set the table on a roar? Not one now to mock your own grinning? Quite chapfallen?

Consider the skull:

The skull is the brain's container. Knowing the bones is helpful to knowing the underlying parts of the brain. Frontal is obvious. Occipital is back of the head. Temporal is difficult to understand – it means temple in both senses. Sphenoid comes from wedge. Zygoma is yoke. Foramen magnum is where the brain joins the spinal cord.

Now get you to my lady's chamber and tell her, let her paint an inch thick, to this favor she must come. Make her laugh at that.

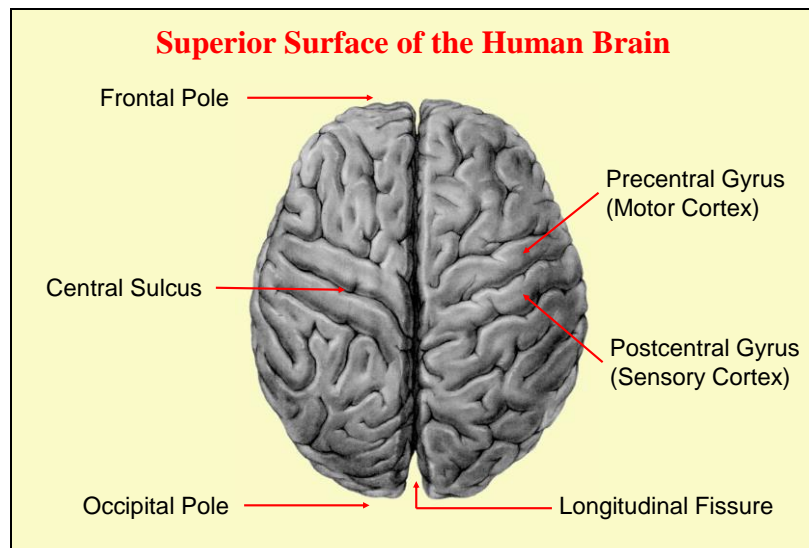


Most of the lobes of the cerebrum are named after the bones which overlie them.

The left figure is the brain viewed from the left. The right figure shows the right half of the brain after it has been cut into right and left halves. The cut separates the two hemispheres of the cerebrum by sectioning the corpus callosum.

The limbic lobe is the part of the brain that borders the brainstem.

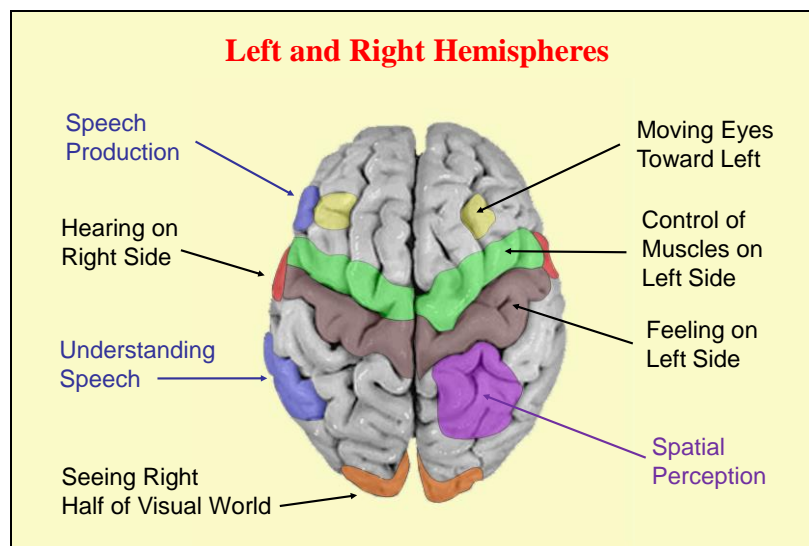
The cerebral covering (or “bark”) over most of the cerebral hemispheres is neocortex (new style cortex) . Some parts of the limbic system such as the hippocampus are old style.



First thing to note is that there are two hemispheres, one for each side of the body. Philosophers among you may wish to consider why two?

Main landmarks are the longitudinal fissure (clef) and the central sulcus (furrow). The convex regions of the cortical convolutions are called “gyri.”

Sensory and motor cortex are behind and in front of the central sulcus, respectively.



A functional view of the top of the brain.

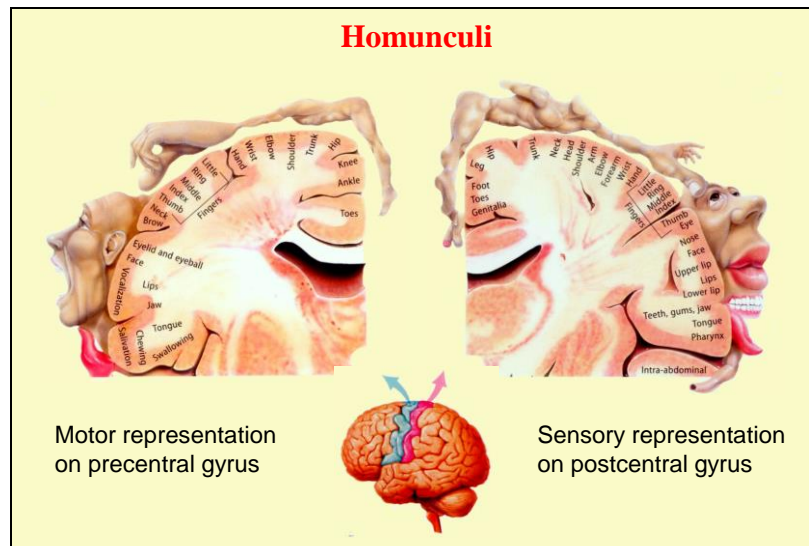
Sensation: seeing, hearing, bodily feeling

Perception: space, speech

Motor: body, eyes, speech.

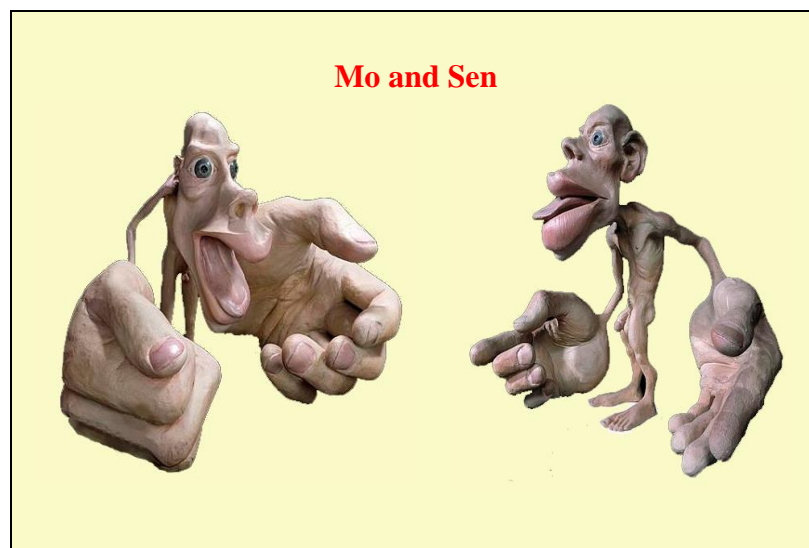
Note that there are two sides to the brain with the right brain controlling the left side of the body and vice versa.

Note that speech (blue) is left sided (except in a small percentage of left-handed people).



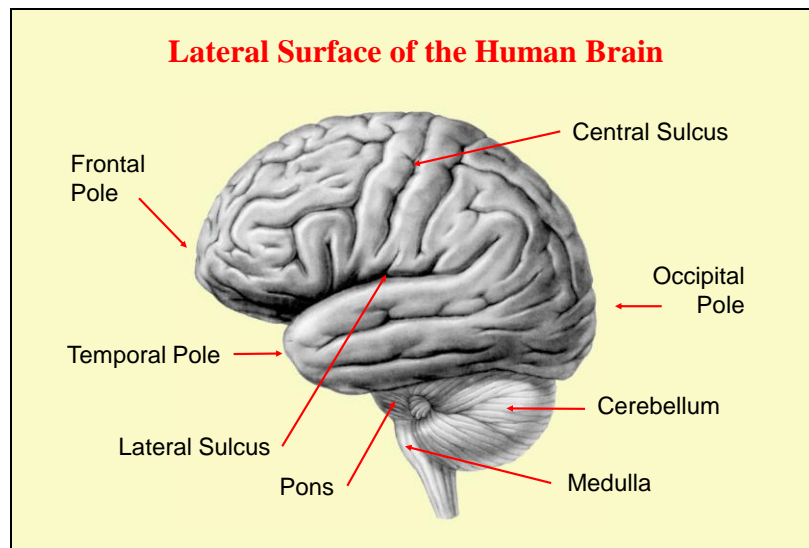
The representation of the body on the pre- and post-central gyri is organized from the toes in the longitudinal fissure to the tongue in the lateral sulcus.

Maps of the little man (homunculi) on the surface of the brain.

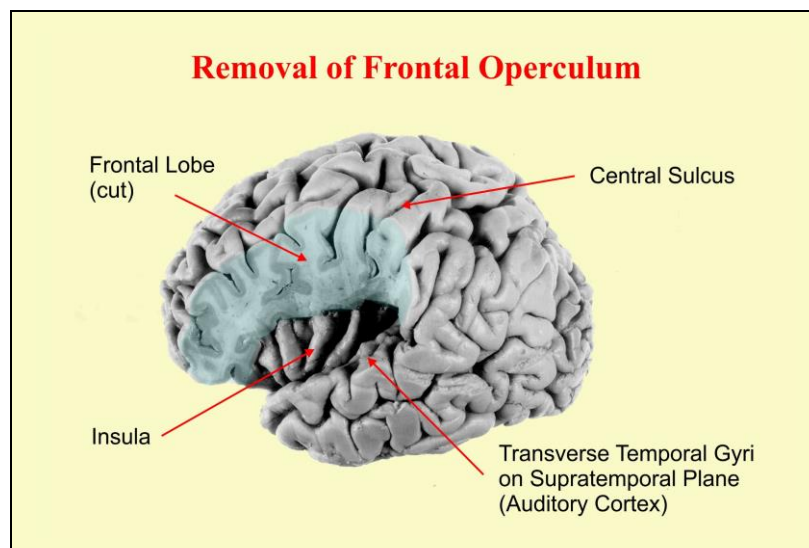


Different parts of the body have different amounts of cortical representation. Motor on the left; sensory on the right. The hands occupy a much larger area than the feet.

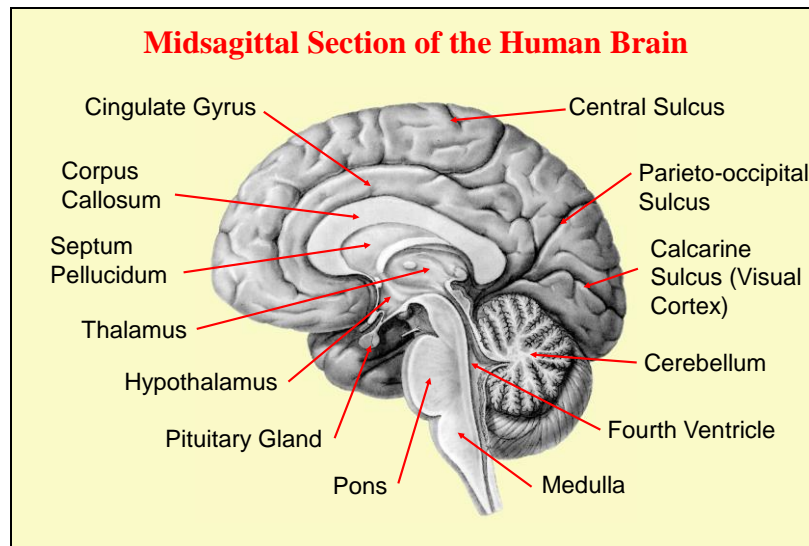
Mo differs from Sen in that he has very little representation for his genitalia. All sensation, no control.



From the side the main landmarks are the central sulcus and lateral sulcus. We can also see the cerebellum nestled underneath the occipital lobes. And the brainstem that connects the cerebrum to the spinal cord. With the pons (the bridge to the cerebellum) and the medulla (in the middle between the brain and spinal cord)



We now remove the operculum (covering) to show the insula. This is an island of cortex deep within the lateral sulcus. The insular cortex is involved in emotions, and internal sensations (such as taste), On top of the temporal lobe is the auditory cortex.



Sagittal comes from the way we shoot arrows.

Major landmark is the corpus callosum – the set of fibers that link the two hemispheres. These are the fibers that are cut in split-brain surgery.

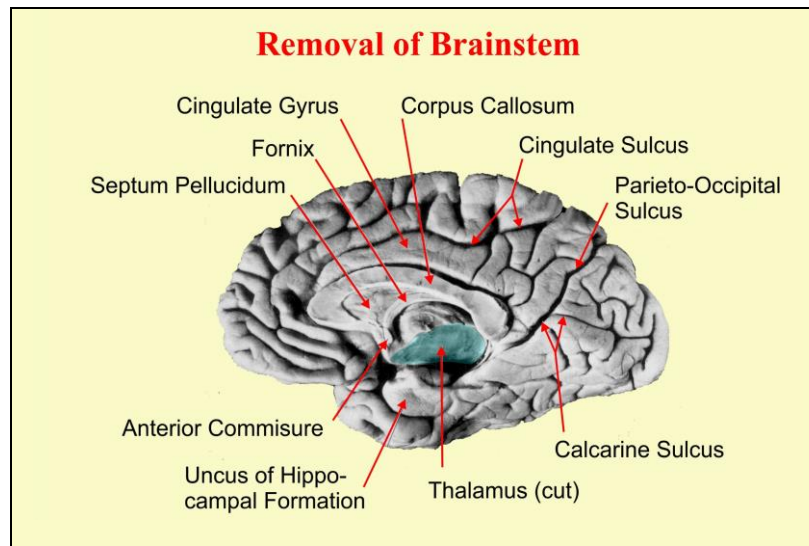
Underneath is the translucent partition between the lateral ventricles (containing the cerebrospinal fluid within the hemispheres)

Cingulate gyrus is the girdle between cortex and the brain's central core (brain stem and thalamus)

At the back of the brain is the visual cortex – the calcarine sulcus is named after the cock's spur.

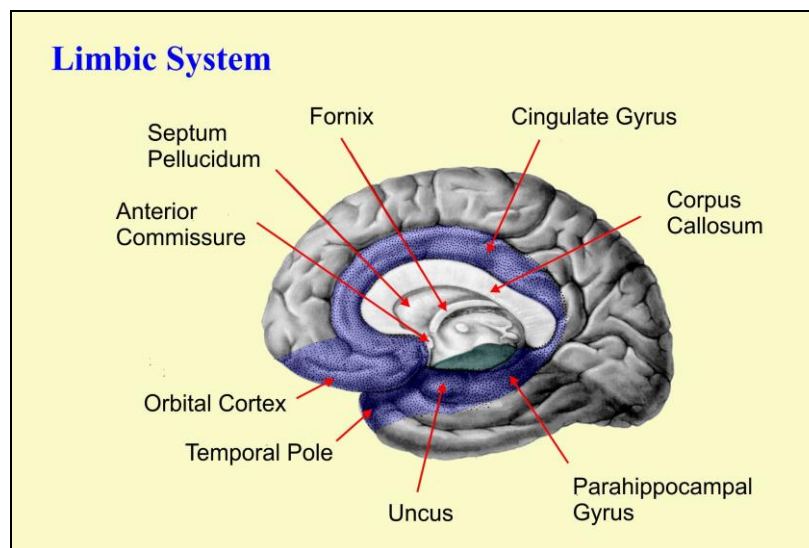
Brainstem consists of medulla, pons and midbrain.

Top of the brainstem is the thalamus. Underneath it the hypothalamus. Thalamus means bedroom or bed. Why the thalamus is called this unknown. Yet almost everything goes through the thalamus – just like the bed is the basis of human existence.



When we take away the brainstem we can see the medial temporal lobe. The uncus is the hook at the anterior end of the hippocampus.

The fornix is the arching pathway from the hippocampus to the thalamus.

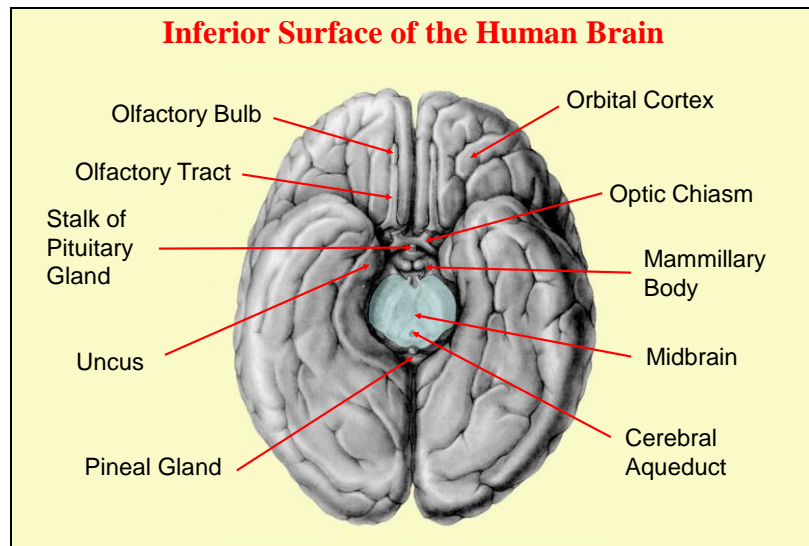


We now can clearly see the limbic system encircling the central core of the brain.

Cingulate gyrus we have already seen. Now revealed is the parahippocampal gyrus inside of which is the hippocampus.

Other parts of the limbic system are the temporal pole containing the amygdala and the orbital cortex of the frontal lobe. This was where the icepick entered in frontal lobectomy.

The limbic system is important for memory and emotion.



The uncus is better seen from the bottom of the brain.

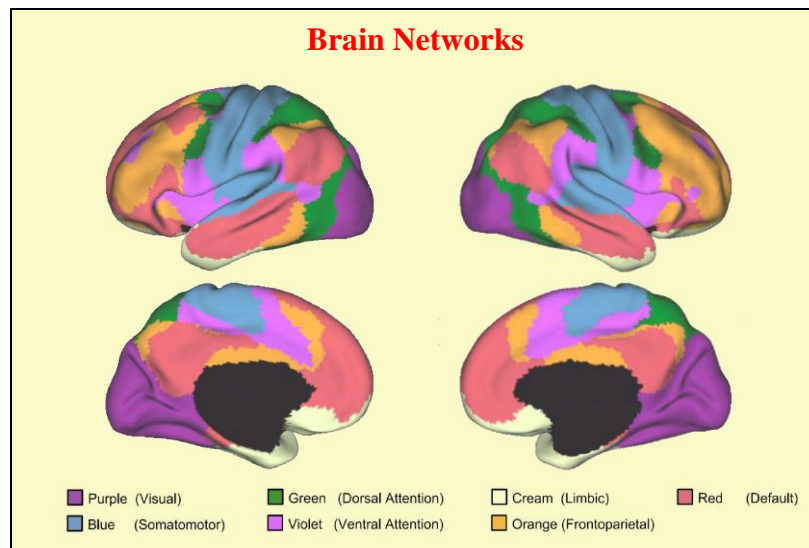
We can see the olfactory nerves lying on the orbital surface of the brain (so-called because it is above the eyeballs).

The olfactory nerves are the only sensory nerves that go directly to the cortex without passing through the thalamus. They connect to the limbic system. As we shall see they are important to memory and emotion. Smell is a powerful trigger for both.

There are two glands on this view of the brain, the pineal at the back of the thalamus and the pituitary at the bottom of the hypothalamus.

In front of the pituitary is the optic chiasm where fibers from the right eye go to the left brain and vice versa.

Behind the pituitary are the mammillary bodies (named after the nipples) – where the fornix ends up.



So far we have been dividing the brain up by the various sulci.

However, the brain is much more connected than divided. Areas of the frontal lobe are closely connected to the parietal lobe (orange, also red).

This is a recent figure showing the various ways that different areas of the brain work together in networks.

A more abstract view of the brain to show function rather than anatomy. Like the paintings of the Tachism movement in France.

We shall return to this in later sessions.

Quiz 1A

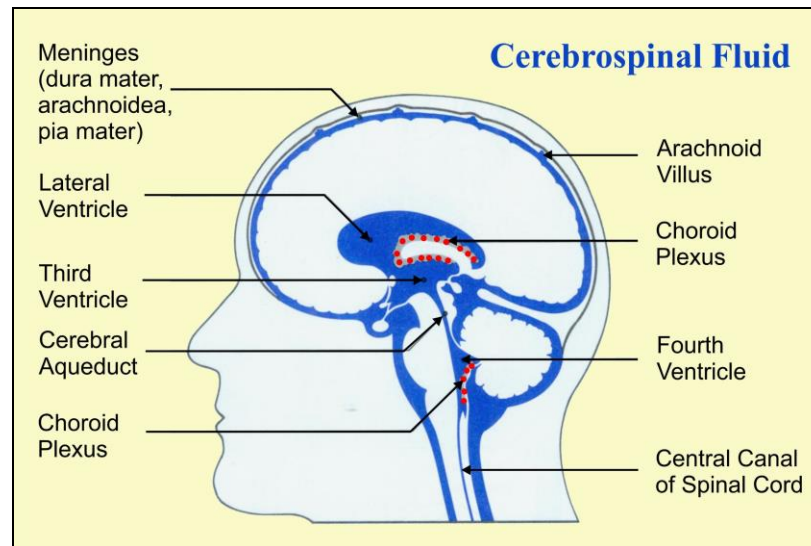
- The corpus callosum connects
 - motor cortex to the spinal cord
 - pons to cerebellum
 - left and right hemispheres
 - hippocampus to mammillary body
- The primary sensory cortex for the hand is located in
 - frontal lobe
 - superior temporal gyrus
 - calcarine fissure
 - postcentral gyrus

3. _____

4. _____

5. _____

Throughout this course I shall present little quizzes. These are meant to demonstrate to you how much you have learned.



The brain is covered by three membranes – the tough mother (dura mater), the gentle mother (pia mater) and the spider (arachnoid). The space between the dura and the pia contains the cerebrospinal fluid.

This fluid acts as a shock-absorber. It also keeps the brain clean by flushing out the waste products of brain metabolism.

As well as covering the outside of the brain, the cerebrospinal fluid also occupies four spaces within the brain – the ventricles.

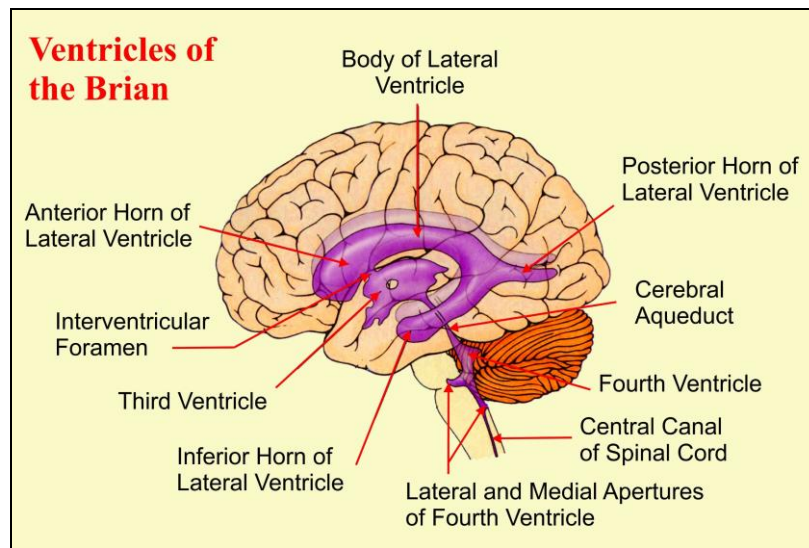
The two lateral ventricles are within the cerebral hemispheres. The third ventricle is between the two thalami.

A small channel through the midbrain (aqueduct) connects the third ventricle to the fourth ventricle which lies between the pons and the cerebellum.

The cerebrospinal fluid is secreted from the blood through the choroid plexuses that exist in the ventricles.

The fluid exits from the ventricles through openings in the fourth ventricle.

It percolates over the cerebrum and is then absorbed back into the veins through arachnoid villi (thick hairs).

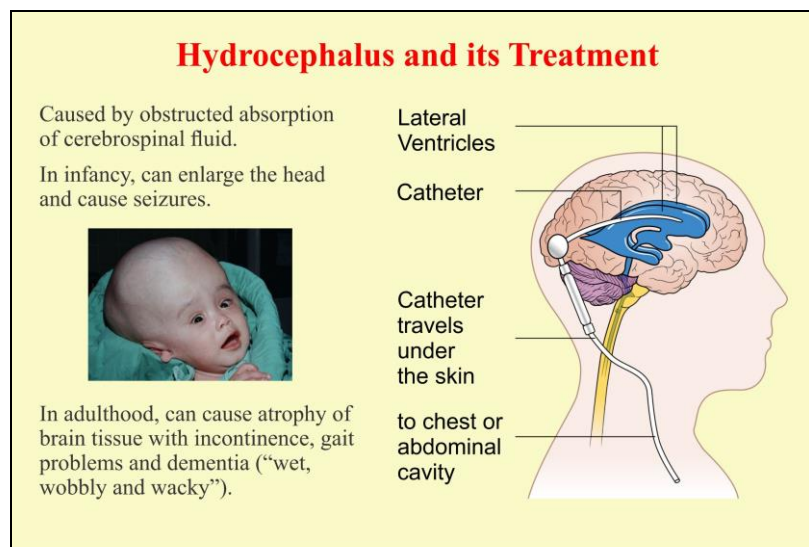


The three-dimensional structure of the ventricular system is quite complex. Each of the lateral ventricles has a body and three “horns” – anterior, posterior and inferior.

This three dimensional structure can be better visualized if we rotate it in three dimensions.

A rotating 3-d reconstruction is at

https://commons.wikimedia.org/wiki/File:Human_Ventricular_system_colored_and_animated.gif

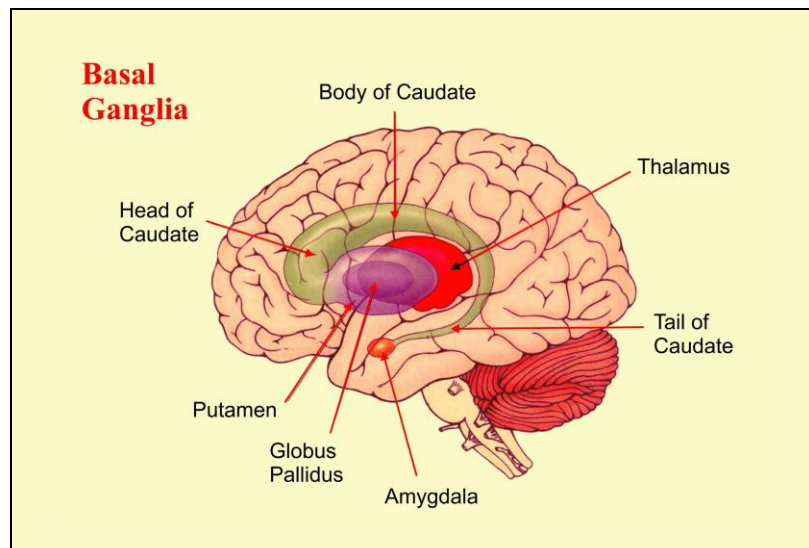


Hydrocephalus is caused by obstruction to the flow of cerebrospinal fluid.

This obstruction can occur in the aqueduct, or in the meninges following an infection.

In adulthood increased pressure cannot enlarge the head because of the rigidity of the skull. It causes atrophy (wasting away) of brain tissue.

The increased pressure can be relieved by a catheter that drains the fluid from the enlarged lateral ventricles to the chest or abdomen. Note that the catheter usually goes in the right lateral ventricle. This does not interfere with speech processes in the left hemisphere.



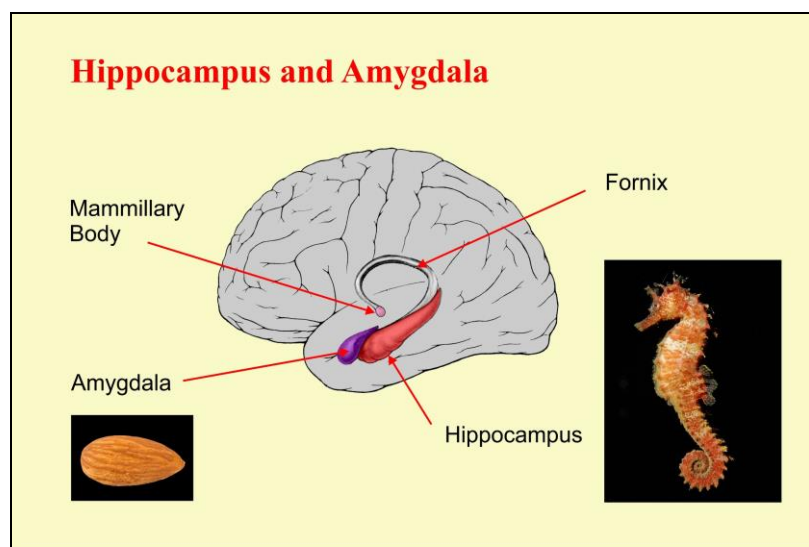
Within the circular form of the lateral ventricles lie the basal ganglia (purple and green). These are very important for motor control.

When viewed from the side, they look a little like a mouse with a long tail.

The caudate (tail) goes from the anterior to the inferior horn of the lateral ventricle. It forms the ventricle's lateral wall.

In the inferior horn it ends just before the amygdala (almond)

It is separated from the other nuclei – the putamen (pruned) and pallidus by the internal capsule which connects the cortex to the thalamus and brainstem.

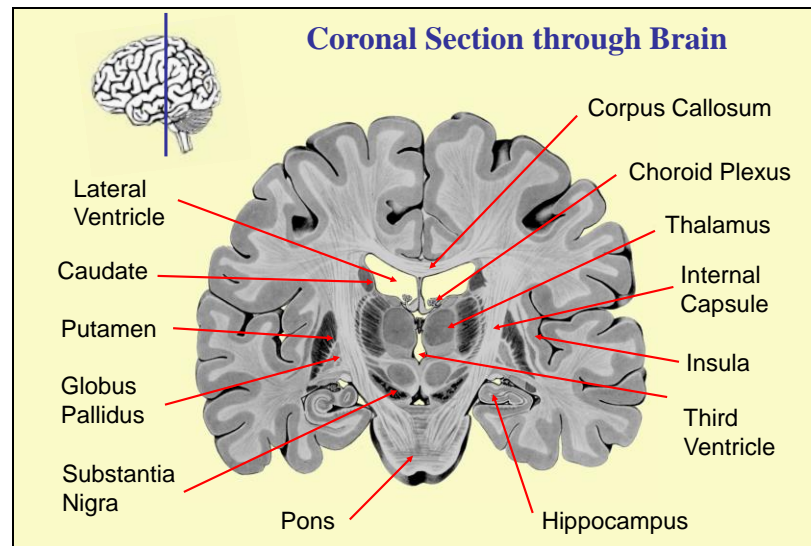


The amygdala (almond) is involved in emotions.

The other important area that is adjacent to the lateral ventricle is the hippocampus (sea horse).

You can see the uncus at the neck of the seahorse and the fornix coiled up in its tail.

The hippocampus is in the medial wall of the lateral ventricle whereas the tail of the caudate is in the lateral wall. The main outflow from the hippocampus goes through the fornix to the mammillary body. The hippocampus is essential for encoding and recalling memories.



We have looked at the brain from the outside and from the inside.
Now we shall try to see if we can put it all together in a slice through the brain.
There is a lot to see in this illustration, so we shall go slowly.

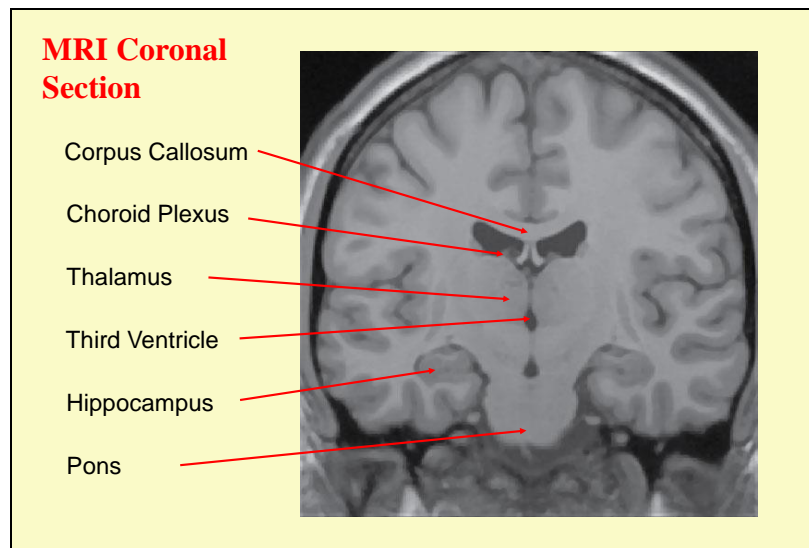
We first identify the bodies of the lateral ventricles with the septum pellucidum between them, and then the inferior horn of the lateral ventricle in the temporal lobe.

Above the body of the lateral ventricle is the corpus callosum that connects the two cerebral hemispheres. Within the ventricles are the choroid plexuses which secrete cerebrospinal fluid. Remember those regions which are close to the lateral ventricles – the caudate nucleus (lateral wall) and the hippocampus (medial wall in the temporal lobe).

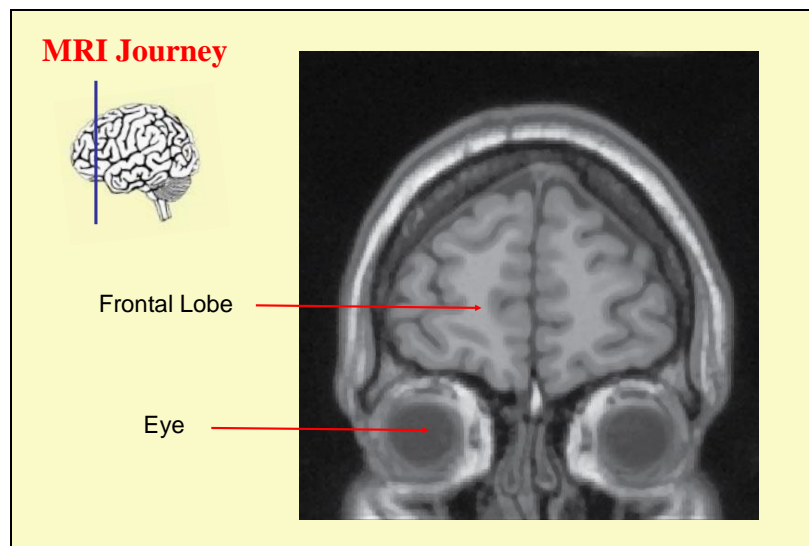
The internal capsule is the pathway that connects the cortex to the thalamus and brainstem. It separates the thalamus from the basal ganglia – the putamen on the outside (that which is pruned) and the paler globus pallidus* inside.

In the brainstem we can see both the midbrain and the pons (at the level of the cerebellum)

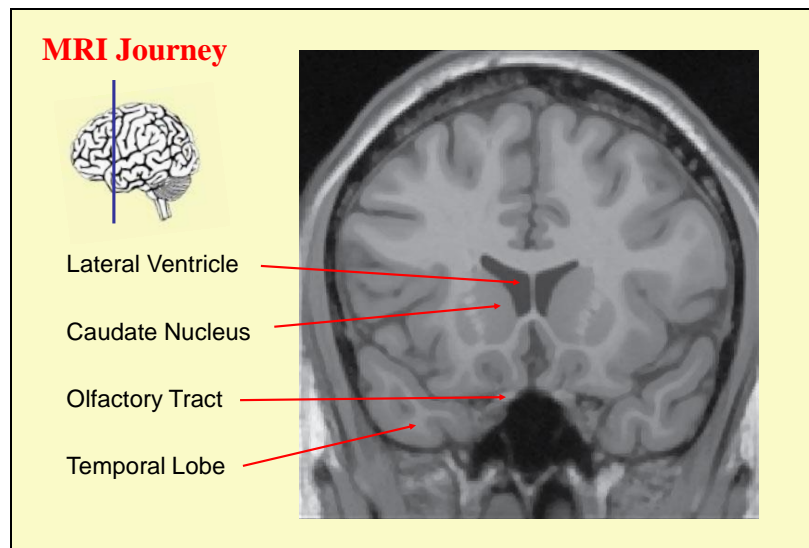
And in the midbrain (between thalamus and pons) is the substantia nigra – black substance. This is the region that is primarily affected by Parkinson's Disease. It connects to the basal ganglia and is involved in motor control.



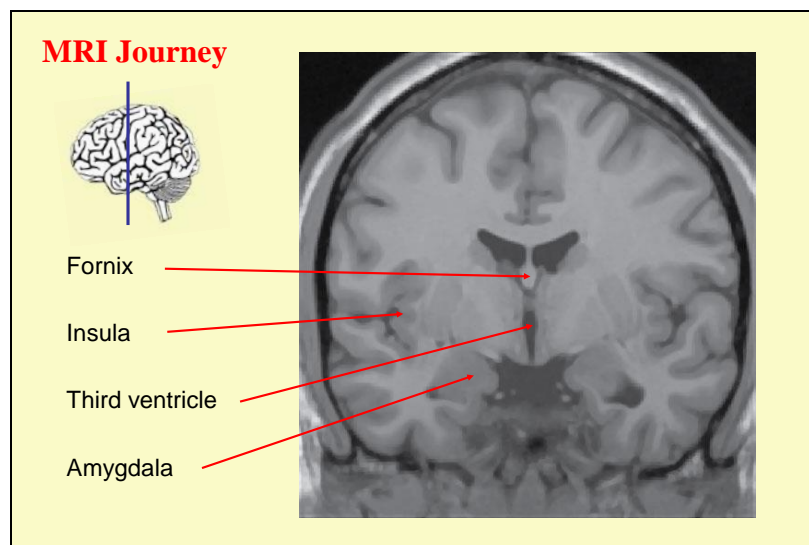
This is a similar section. However rather than an anatomical slice, this is a magnetic resonance image of a living brain.



We shall now look at multiple coronal slices – journeying from the front to the back. At the front of the brain we have the eyeballs and the frontal lobe. The inferior surface of the frontal lobe is called the orbital cortex since it is above the orbits.



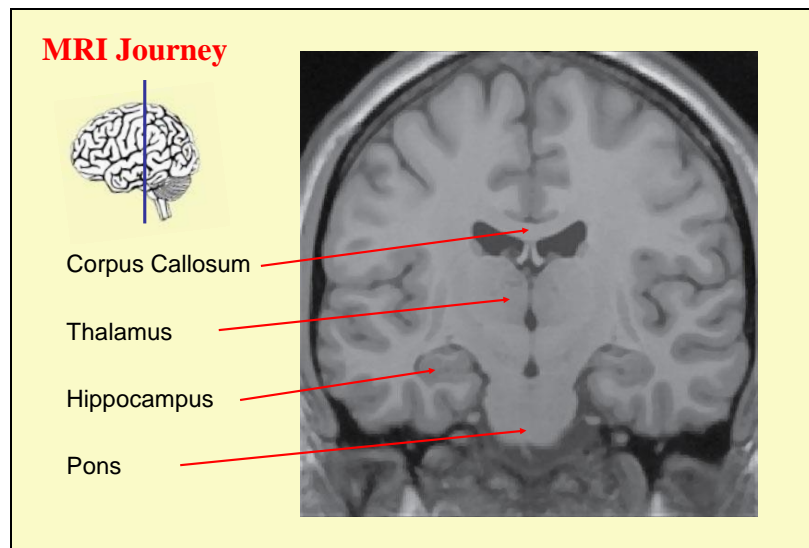
As we go backward we reach the lateral ventricle. On its lateral surface is the caudate nucleus. On the orbital surface of the frontal lobe is the olfactory tract. And we have made our first cut into the temporal lobe.



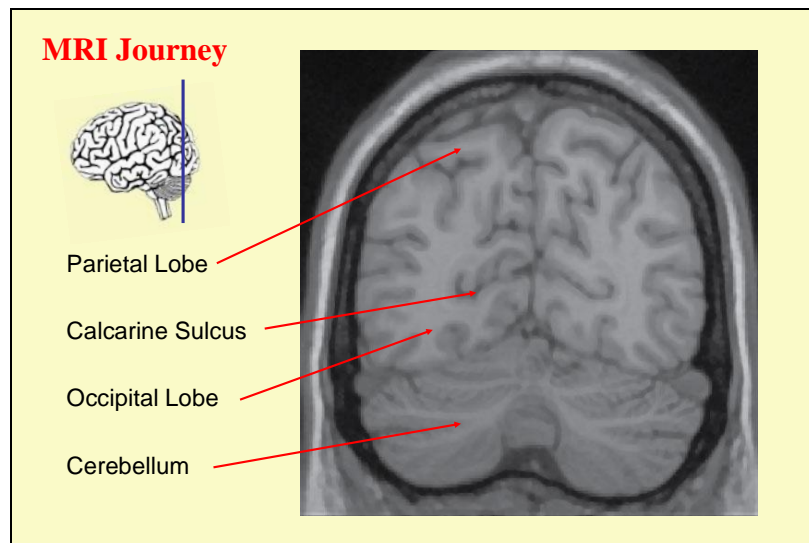
Further back we see the amygdala in the anterior temporal lobe and the beginning of the inferior horn of the lateral ventricle.

The third ventricle lies between the two thalami. Above the ventricle is the highest point of the fornix. This arching pathway connects the hippocampus to the thalamus.

The insula is in the depths of the lateral sulcus.



Now we are close to where we began to look at the coronal sections.
The hippocampus lies in the inferior horn of the lateral ventricle
The body of the lateral ventricle with the corpus callosum above and the fornix and choroid plexus below.



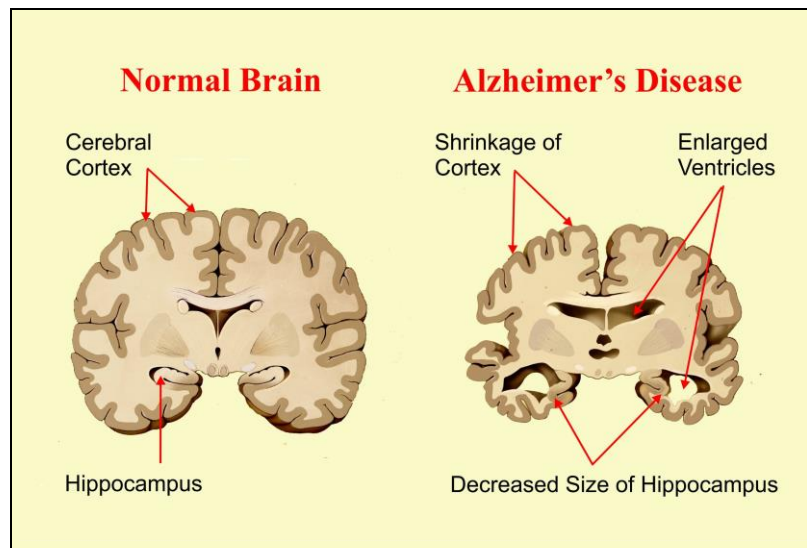
Moving toward the back we see the cerebellum beneath the occipital lobe.
The visual cortex is in the calcarine sulcus.

Now we are up to speed, we can run the sections together:
Human Brain: The Movie.

This is available on the webpage at slow and fast speeds.

If you wish to see more of this type of MRI information

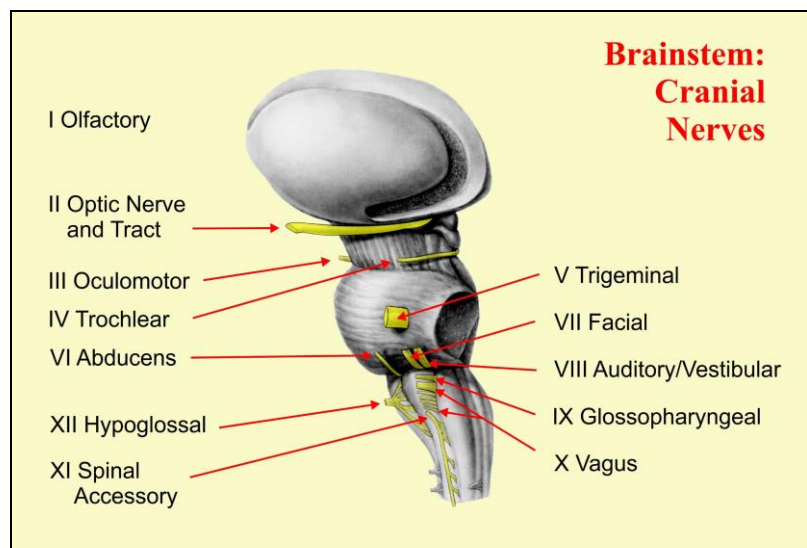
<http://www.pbs.org/wgbh/nova/assets/swf/1/mapping-the-brain/mapping-the-brain.html>



Remember what we learned about Alzheimer's Disease at the beginning of today's presentation. We should now be familiar with the section from the normal brain – ventricles, corpus callosum, basal ganglia and hippocampus.

In Alzheimer's Disease, the main findings on brain pathology are the enlarged ventricles, the shrinkage of the cortex and the prominent atrophy of the hippocampus.

All these findings can now be measured in the living person using MRI.



So far, brain anatomy has been relatively easy.

With the brainstem everything becomes very complicated. Having to study the brainstem is when medical students decide that cardiology or general practice would be much more interesting than neurology. You may therefore wish to skip this part of the presentation.

The brainstem is where all of the cranial nerves except the olfactory and optic nerves make their connections.

There are three nerves to move the eyes: oculomotor, trochlear, abducens.

There are two nerves for the face – the trigeminal (with three main branches) and the facial.

The auditory-vestibular nerve provides hearing and balance.

The tongue is innervated by the hypoglossal (motor) and glossopharyngeal (mainly sensory)

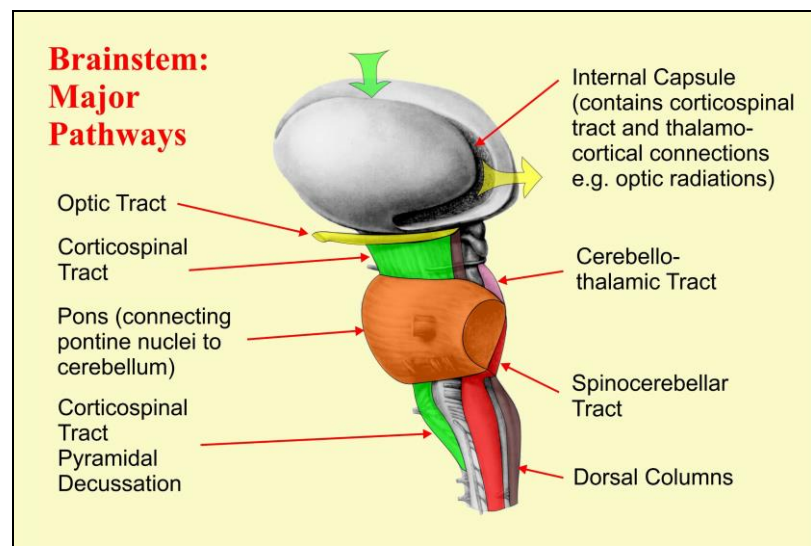
The spinal accessory innervates the neck muscles. The vagus nerves wanders throughout the body innervating most of our internal organs – slowing the heart and speeding the bowel.

There are mnemonics to remember the cranial nerves. A politically correct mnemonic is

On old Olympus' towering top a Finn and German viewed some hops

To determine their function (sensory, motor, both) in a somewhat less politically correct form::

Some say marry money but my brother says big boobs matter more.

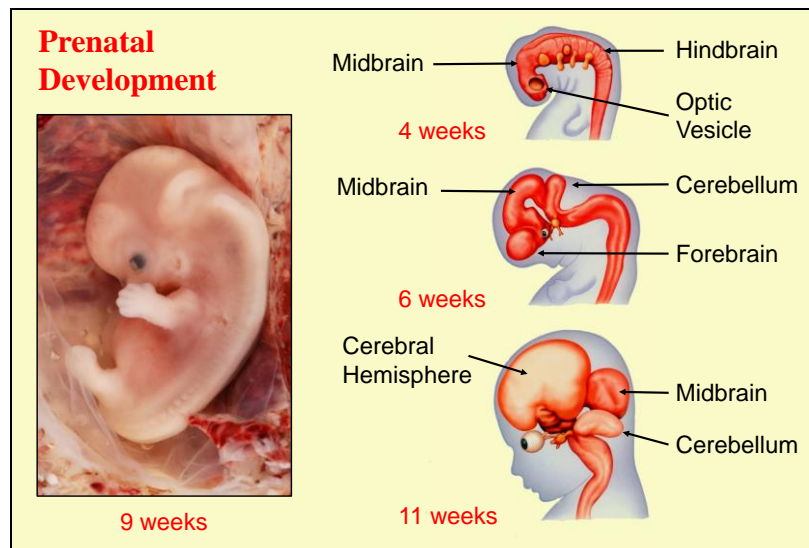


The brainstem contains the pathways that link the spinal cord, the cerebrum, and the cerebellum. The main motor pathway is in green – the corticospinal tract, also known as the pyramidal tract from the shape of its decussation (like an X). When the cortex decides to move the muscles, the information travels down through the internal capsule and on to the spinal cord.

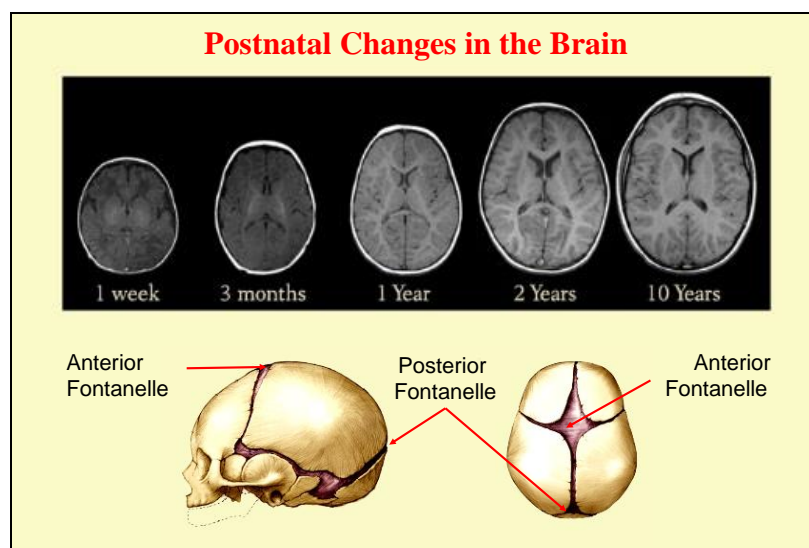
The bodily sensations come up the dorsal columns of the spinal cord, cross over at the top of the medulla and carry on through the midbrain to the thalamus and cortex.

The cerebellum receives two main inputs – from the cortex through the pontine nuclei and from the spinal cord through the spinocerebellar pathway. It has one main output back to the thalamus (and thence to the cortex).

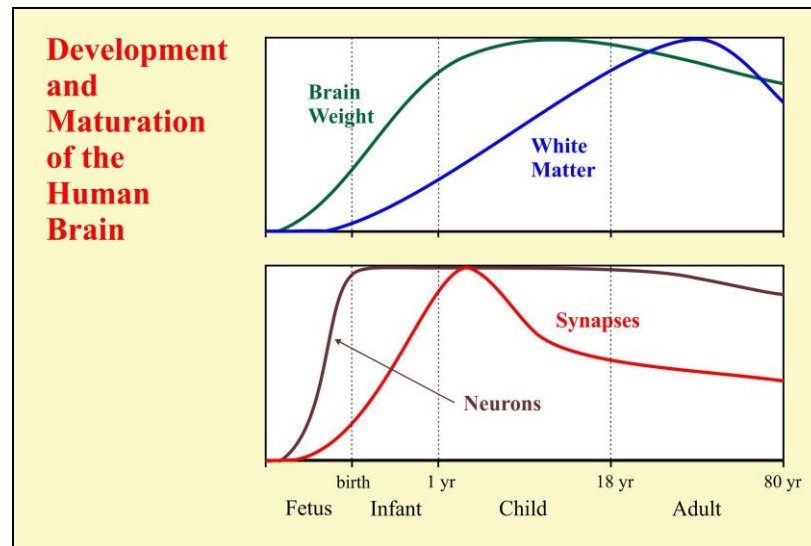
Visual information comes in via the optic nerves crosses over (or not) in the optic chiasm and then goes along the optic tract to the thalamus before going out to the visual cortex through the internal capsule.



This shows the brain in a 9-week fetus. You can see the optic vesicle that will make the eye (dark) and the otic vesicle that will make the ear (light). The brainstem is bending, the cerebellum is sprouting and the cerebrum is just beginning. The cerebral hemispheres begin to expand over the rest of the brain after 4 weeks and continue to expand until birth.



After birth the brain grows rapidly until the age of 2 years when it is about 90% adult size. The growth is allowed by the elastic fontanelles between the skull bones. The posterior fontanelle closes by about 3 months and the anterior closes at about 18 months.

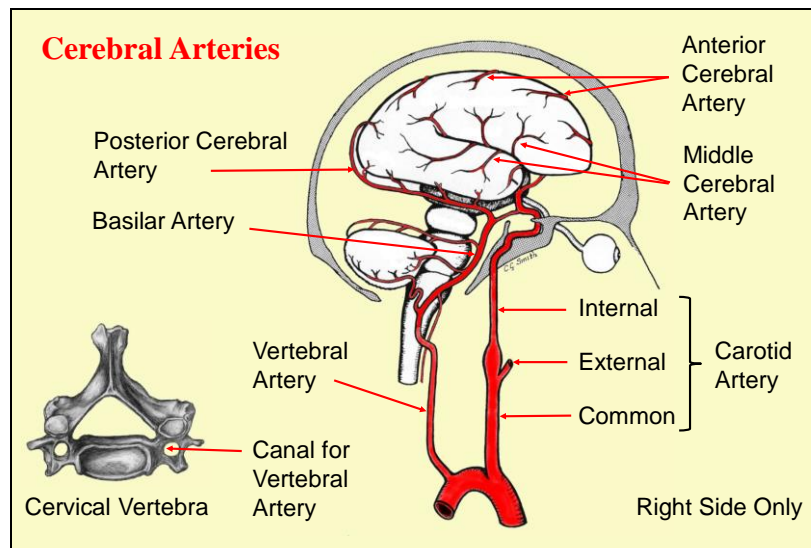


The brain keeps growing until our mid teens and then slowly decreases in size. The time scale is not linear – I have spread out the earlier times and compressed the later.

The number of neurons does not change much after birth. A few die and are replaced. Yet basically we have the same neurons now that we were born with.. They do not replicate like other cells in the body. At least that is the major rule. Recently there have been some studies showing that some neurons might replicate but these are not many. Although neurons do not generally replicate, they can regenerate their processes if the cell bodies are preserved.

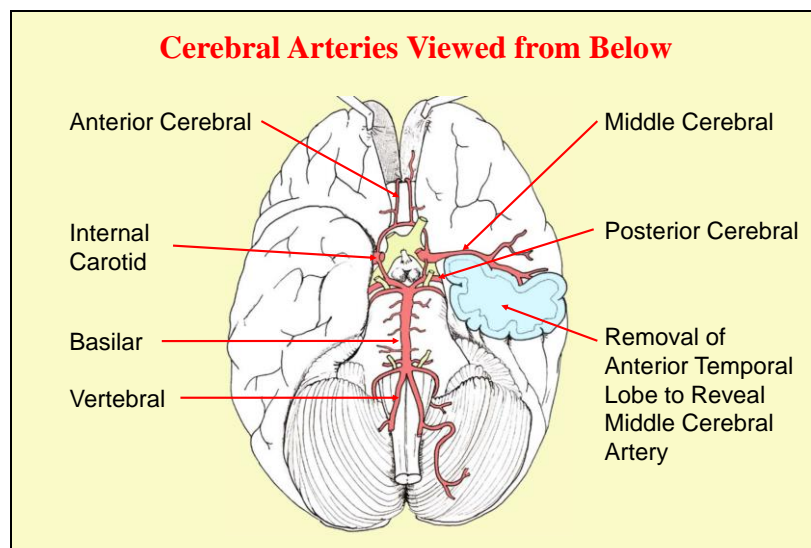
The number of synapses increases until the age of about 3-5 years. During these early years we learn more rapidly than at any other time in our lives. We learn to walk and run, to speak and think, We start to remember. And we become aware of ourselves. After the age of 5 years the number of synapses are pruned as we learn which ones work best. Proliferation and Pruning. Myelination of pathways, which speeds the transmission of information, continues into adulthood, with the frontal lobes being the last to myelinate fully (by about age 30).

I am afraid I cannot sugar-coat reality - nothing gets bigger, better or faster after about 60 years of age. Though wisdom accumulates we are not sure how to measure it.



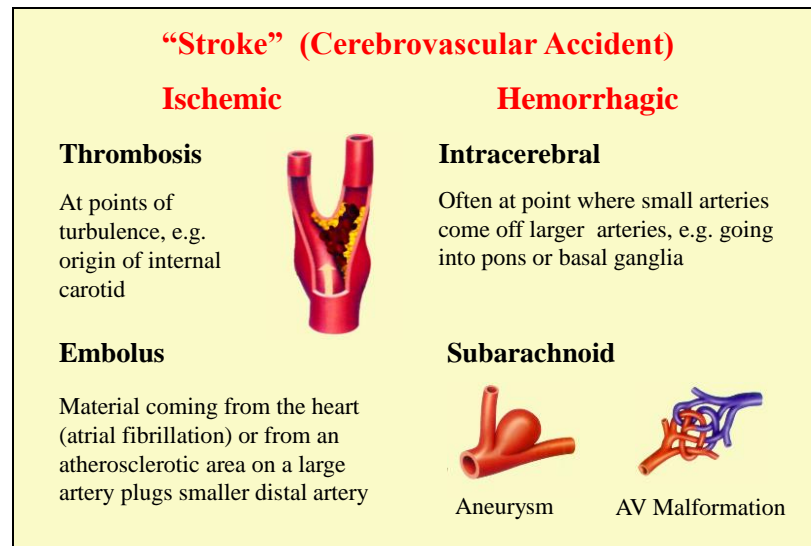
The brain receives its nutrition and oxygen via four arteries. The two internal carotids ascend in the lateral neck and distribute to the anterior and middle cerebral arteries. You can feel the carotid just below the angle of the jaw. Do not press too hard!

The two vertebral arteries travel up to the brain in special canals in the cervical vertebrae. They join to form the basilar artery which runs up the front of the brainstem and divides into the two posterior cerebral arteries.

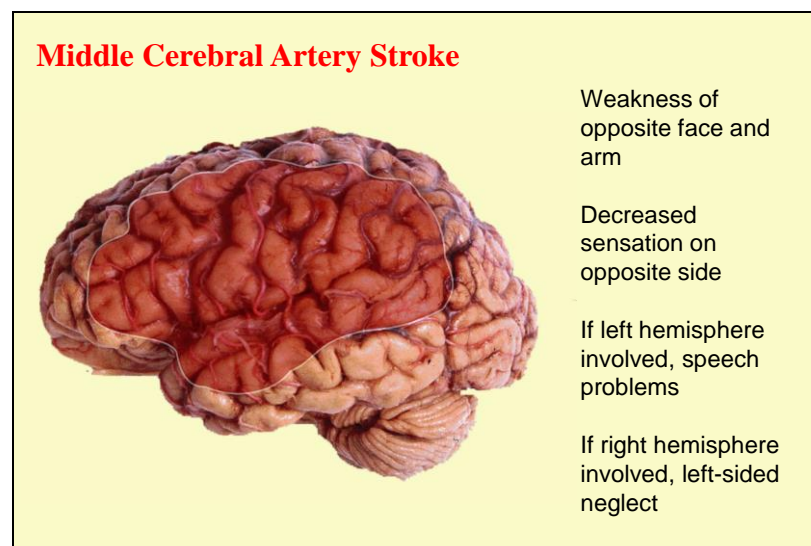


Viewed from the base of the brain we can see that the four arteries communicate with each other giving a circle of arteries – named the circle of Willis after its discoverer, a 17th Century English physician. Thus if one artery is blocked the other arteries may sometimes be able to supply the regions of the brain previously supplied by the blocked artery.

An aneurysm (abnormal outpouching of the artery) may occur at the points where the major arteries communicate with each other.







A stroke is a cerebrovascular accident. It can be either ischemic (loss of blood) or hemorrhagic (spilling of blood).



The most common stroke involves the middle cerebral artery – this can be caused by thrombosis of the internal carotid, or an embolus from the heart or internal carotid into the middle cerebral artery.

Such a stroke causes weakness and decreased sensation in the opposite face and arm, often with some sparing of the leg. If the left hemisphere is involved speech is affected and if the right hemisphere is involved attention is affected.

Treatment of Stroke

FACE.	ARMS.	SPEECH.	TIME.
			
Has their face fallen on one side? Can they smile?	Can they raise both arms and keep them there?	Is their speech slurred?	Call 911 if you see any single one of these signs.


Treatment must be initiated rapidly to prevent or attenuate brain damage. Treatment of ischemic stroke consists of drugs that dissolve the clot and/or surgical removal of the clot with an arterial catheter. Treatment of hemorrhagic stroke is to stop the bleeding (e.g. clipping an aneurysm).

Nowadays there are treatments for stroke – these involve dissolving the clot with anticoagulants or radio-surgical removal of the clot. It is essential that treatment be started rapidly.


The acronym FAST is an easy way to remember the most common signs of a stroke – facial drooping, arm weakness, slurred speech. It is important to get medical help as quickly as possible if any of these signs occur.

Transient Ischemic Attack (“Mini-Stroke”)

Embolus plugs artery, stopping blood flow



Embolus breaks apart and blood flow is restored



Symptoms: Ischemia in distribution of internal carotid causes weakness on one side of the body (especially face and arm) and speech problems if left hemisphere involved. Ischemia in vertebro-basilar distribution causes vertigo, double vision and visual loss.

Sometimes an embolus blocks an artery causing symptoms and later breaks up with resolution of the symptoms. This is a transient ischemic attack. These are extremely important to recognize as they may be a forerunner of a full-blown stroke.



Stacey Yepes

This video shows a transient ischemic attack in process.

<https://www.youtube.com/watch?v=D7YYWVNG4jA>

Her speech is slurred because of the facial weakness. She has no language problem because the ischemia is on the right side of the brain. Speech is controlled through the left hemisphere.

Quiz 1B

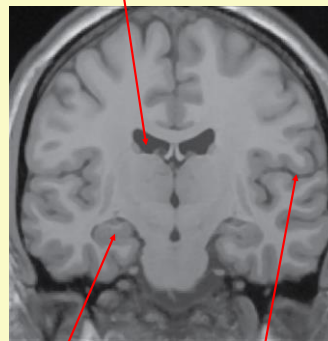
1. The cerebrospinal fluid is produced by the

- A) pineal gland
- B) choroid plexus
- C) arachnoid villi
- D) pyramidal tract

2. The primary motor cortex for the hand receives blood from

- A) middle cerebral artery
- B) posterior cerebral artery
- C) vertebral artery
- D) anterior spinal artery

3. _____



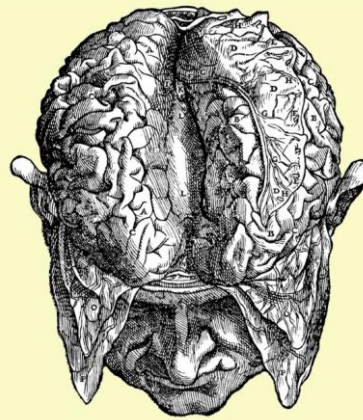
4. _____

5. _____

The Human Brain

This is a gift that I have, simple, simple; a foolish extravagant spirit, full of forms, figures, shapes, objects, ideas, apprehensions, motions, revolutions: these are begot in the ventricle of memory, nourished in the womb of pia mater, and delivered upon the mellowing of occasion.

Shakespeare (1598)
Love's Labour's Lost IV:2



Andreas Vesalius, 1543

This is a speech by the school-teacher Holofernes in Shakespeare's *Love's Labour's Lost*. He is describing his ability to spout ideas.

He says that his fantastical notions are begot in the ventricles and nourished in the womb of the pia mater.

Holofernes was aware of the anatomy of Vesalius. Shakespeare had read widely.

Rembrandt was also aware of Versalius in his painting of the *Anatomy Lesson of Dr. Deijman*.

Brain anatomy is important to human culture. .