WORKBOOK BRAIN ANATOMY

Introduction

This anatomy workbook is a tool that we offer so that you will get to know the major parts and important structures of the brain. As a psychologist, an understanding of the overall organisation of the brain is necessary. This practical is a first introduction into the brain's anatomy. It is important that you try to do the tasks on your own.
This workbook belongs to the study material of the course, so questions about it can be asked during the exam.

Authors

Valuable contributions and adaptations to this workbook has have been made by Wijnand Raaijmakers, Elia Formisano, Jos Prickaerts, Anke Sambeth, Eef Theunissen and Michael Capalbo.

Assignment

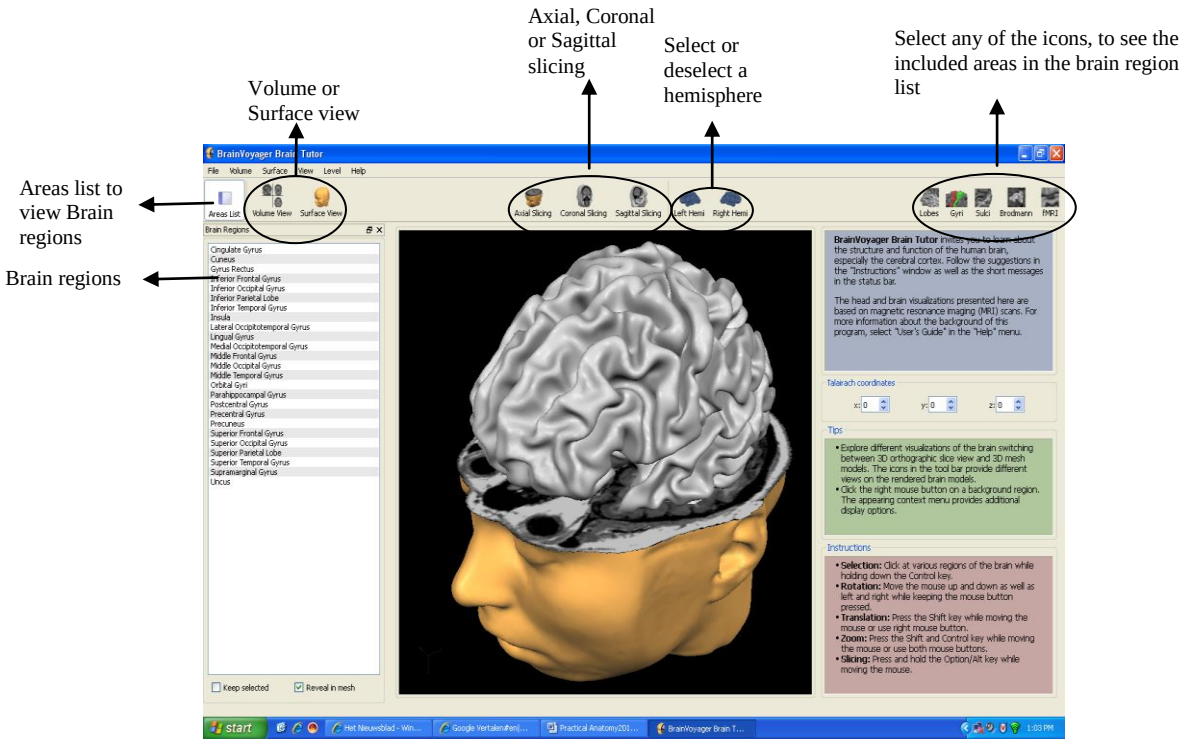
Read the text in this workbook. It gives information about the anatomy and will help you locate the different parts and structures. Each section contains a task and/or questions. Hand in the completed workbook to your tutor before the deadline. Your workbook will be checked and given back to you after.

Sources

To help you with the tasks and questions, you can use a biological psychology or anatomy book, the internet but especially the interactive programs **Brain Tutor** and/or **Genes2Cognition** (G2C). We also have a few plastic brain models, if you want to borrow one for this task, ask your tutor.

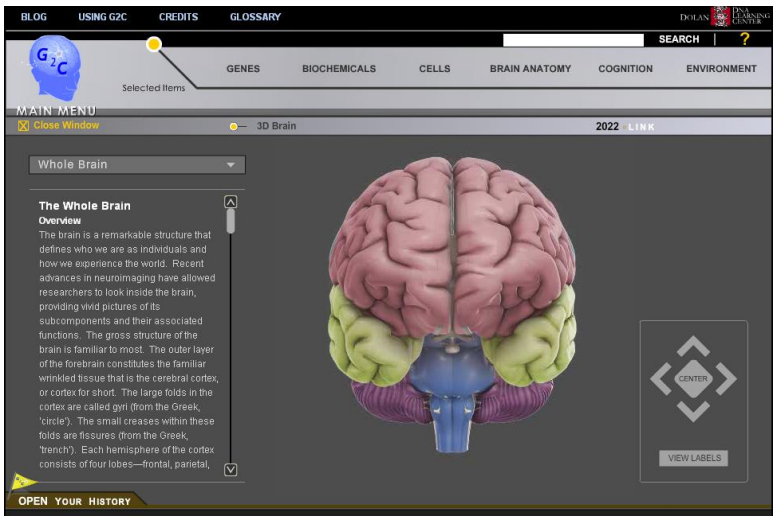
Brain Tutor from Brain Innovation *(see link on the student portal).*

Brain Tutor contains information about the major lobes, gyri, sulci, Brodmann and functional areas of the cerebral cortex. It is available for PC, Mac, Android and iOS. You can simply turn the brain around by clicking and dragging. The information window on the right side will show important information about the selected structure. You may also use the brain regions window to select a brain structure by its name. To use the program, simply follow the guidelines in the panes on the right side.



Genes2Cognition *(see link on the student portal)*

The *G2C Brain* is an interactive 3-D model of the brain, with 29 structures that can be rotated in three-dimensional space. It can be viewed in most web-browsers.
In the left panel, you can select a brain structure. Use the arrows at the right to rotate the brain, in order to get a good view of the structure. Use 'view labels' to learn the substructures of each brain region.



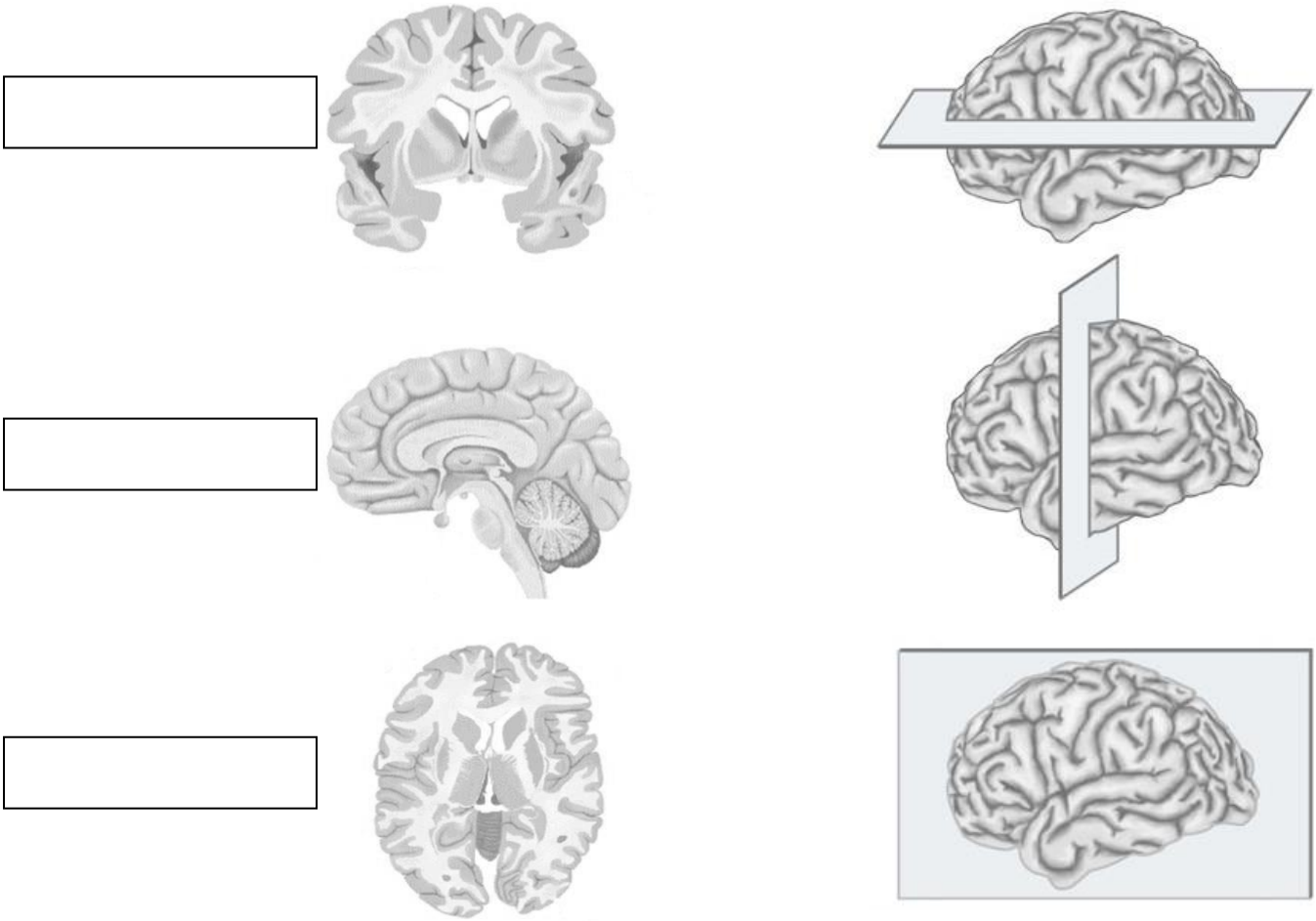
Finding your way in the human brain

In order to study the brain, you first need to understand the terminology that is used to describe the location of structures in the body.

Planes of the brain

Brain slices are often cut in one of three different planes:
Coronal or Frontal plane
Sagittal or Lateral plane
Horizontal or Axial plane

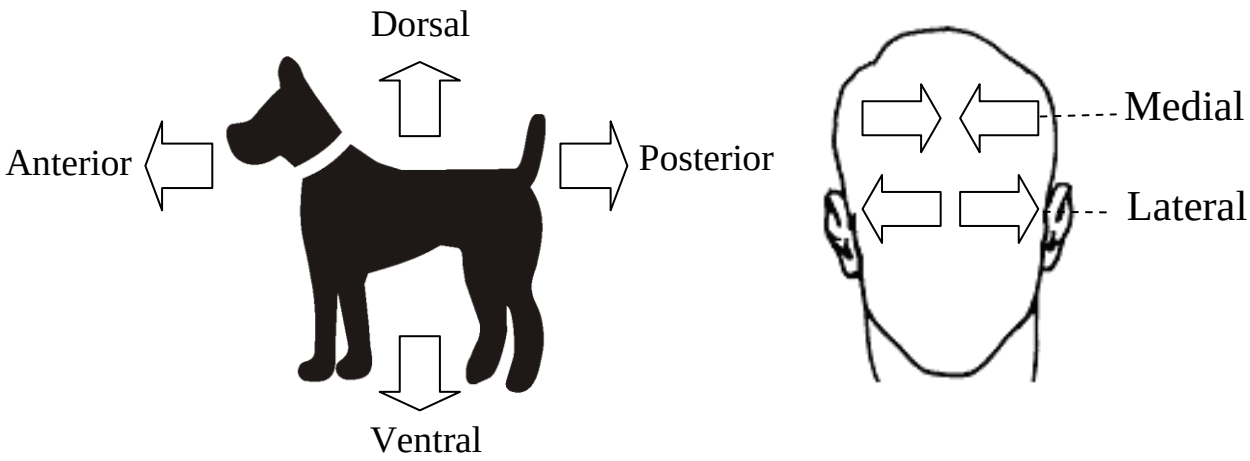
TASK 1: Name each brain slice and connect it to the corresponding cut.
In Brain Tutor you can select Axial Slicing, Coronal Slicing or Sagittal Slicing to see the different planes.



Directions in the brain:

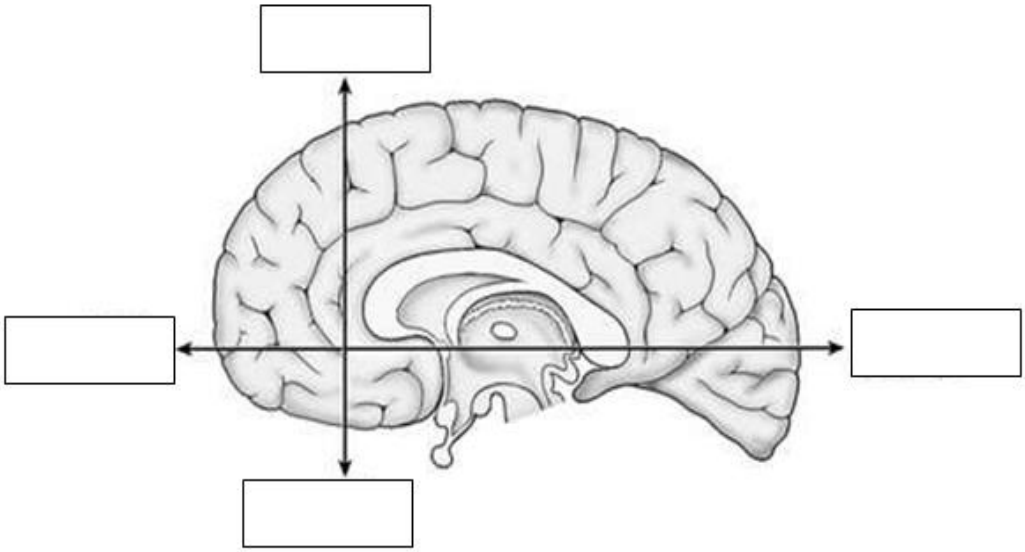
Term	Direction
Anterior/rostral	Towards the nose end (Latin *rostrum=nose)*
Posterior/caudal	Towards the tail end (Latin *cauda=tail)*
Dorsal	Towards the back or top of the head (Latin *dorsum=back)*
Ventral	Towards the chest or bottom of the head (Latin *venter=abdomen)*
Medial	Towards the middle
Lateral	Away from the middle
Inferior	Lower or below
Superior	Upper or above

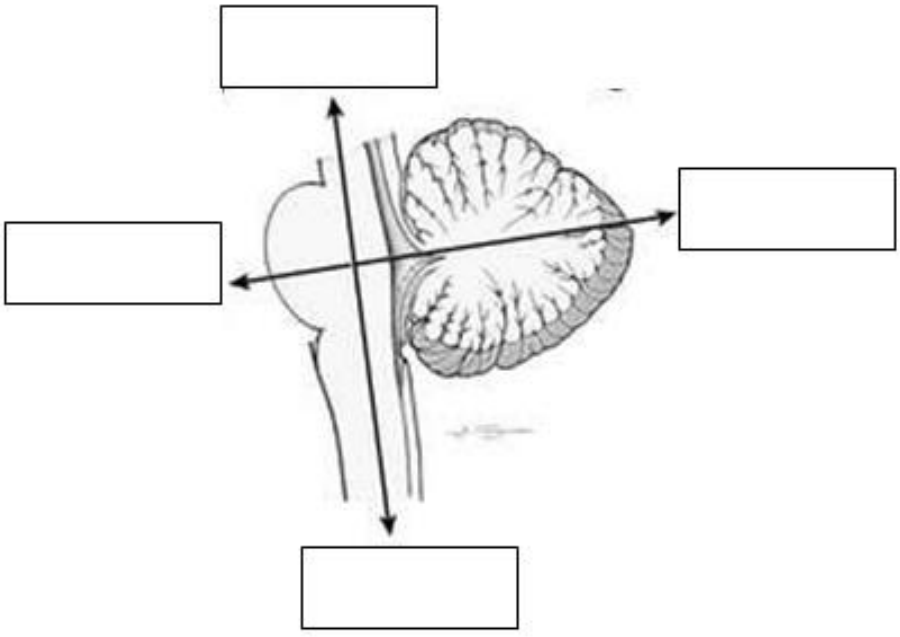
Locations in the nervous system are described **in relation to the orientation of their spinal cord**. This makes the 3-dimensional system of anatomical directions straightforward in animals that run about **on 4 legs**.



IMPORTANT! Because we humans walk on our hind legs, we **changed the orientation** of our brain in relation to our spinal cord, making the system more complicated.

TASK 2: Fill in the corresponding terms in the boxes: Dorsal, Caudal, Rostral and Ventral





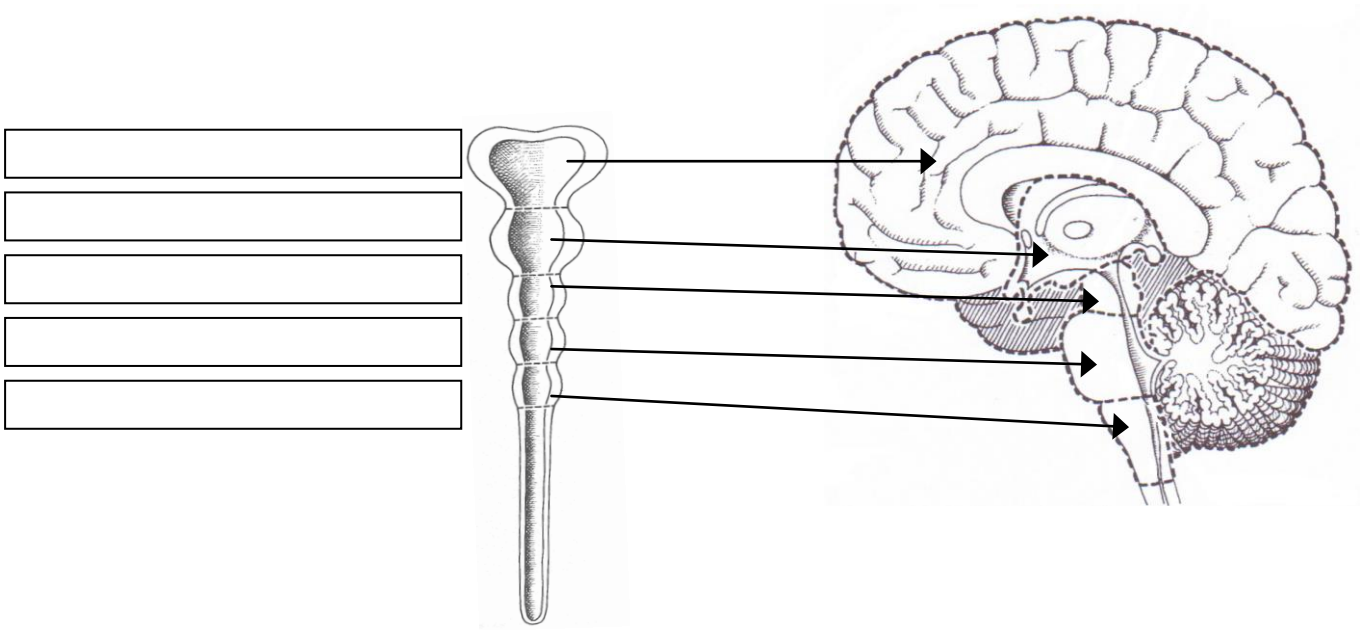
Anatomy of the human brain

1. Development into 5 Brain Divisions

During development, the five embryonic swellings develop into the five major divisions of the adult brain: **diencephalon, mesencephalon, myelencephalon, metencephalon, telencephalon**.

To remember the sequence of these divisions you can use the following trick: ***T***elencephalon is at the ***T***op of the brain, and the other four are arranged below it in alphabetical order.

TASK 3: From the description above, you should be able to fill in the corresponding brain divisions **diencephalon, mesencephalon, myelencephalon, metencephalon, telencephalon**.



2. The outside of the brain

2.1. WATCH CLIP 1 IN THE PRACTICAL FOLDER IN ELEUM

This clip will provide an overview and help you complete the tasks in this part of the practical.

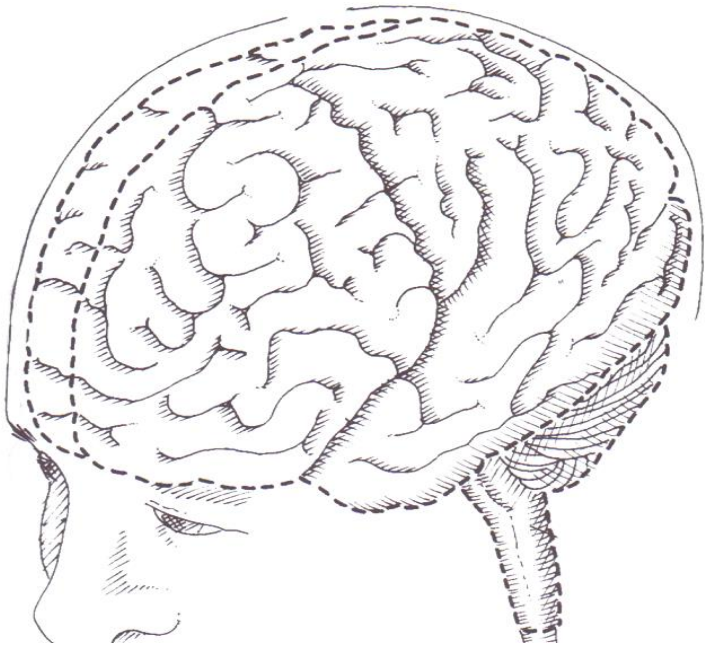
2.2. Cerebral hemispheres and lobes of the cerebral hemispheres

The human brain has four apparent components: the two cerebral **hemispheres** (left and right), the **brain stem** and the **cerebellum.**

TASK 4: Color the **left hemisphere** in red, **cerebellum** in blue and **brain stem** in green.

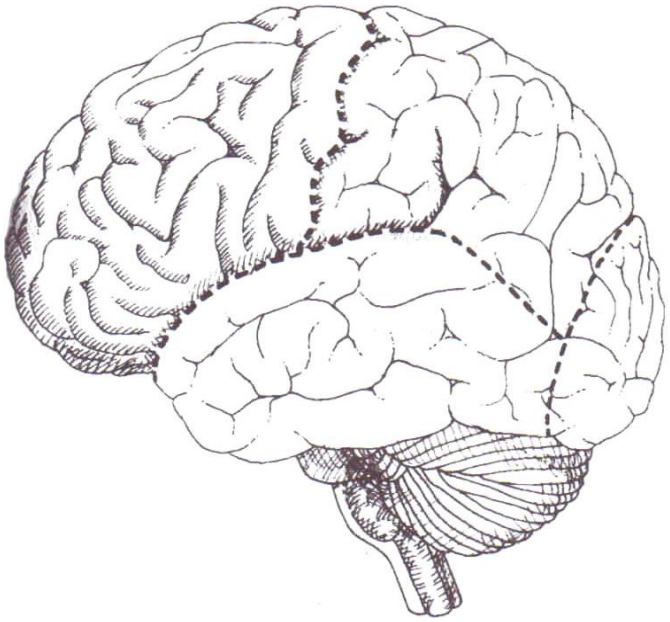
NB: In order to check your answers correctly and efficiently, it is important that you use the colors exactly as they're defined in the task instructions.

G2C: go to 'Whole Brain' to see the cerebellum and brain stem. Or select these structures directly.



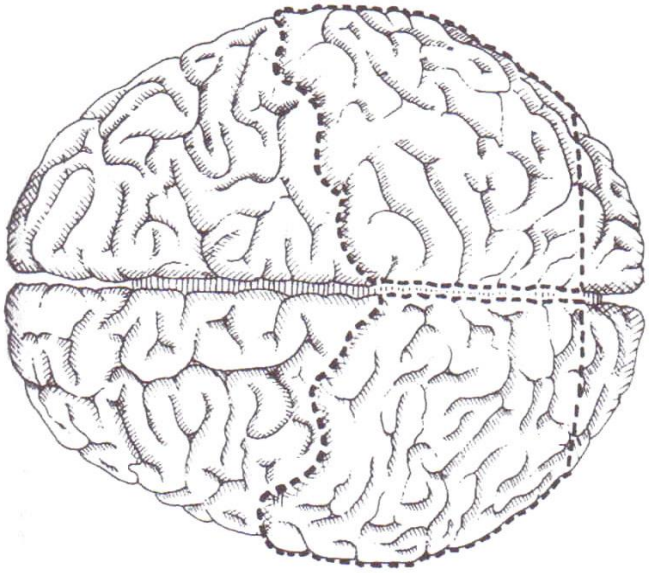
Each cerebral hemisphere is divided into four lobes: **the frontal, parietal, occipital and temporal lobes**

TASK 5: In the next picture, color the 4 lobes as follows: **Frontal** in red, **Parietal** in blue, **Temporal** in green, **Occipital** in yellow.
G2C: go to 'Whole brain' to see the lobes
Brain Tutor: Use Axial or Sagittal slicing, select 'Lobes'. Now you can select the lobes you want to visualize



Below you see a top-view of the brain. You can see that it has a kind of egg-shape. In the front the brain is narrower, while the backside is broader.

TASK 6: Use the same colors to indicate the three lobes that are visible in this top-view.



QUESTIONS 1:
Which lobe is located in the most caudal part of the brain? **The……Lobe**

Which lobe is located in the most inferior part of the brain? **The……Lobe**

2.3. WATCH CLIP 2 IN THE PRACTICAL FOLDER IN ELEUM

This clip will provide an overview and help you complete the tasks in this part of the practical.

2.4. Gyri (coils), fissures and sulci (grooves)

The two cerebral hemispheres display many grooves**,** called **sulci** (large ones are sometimes called *fissures)* and several coils, called **gyri**.

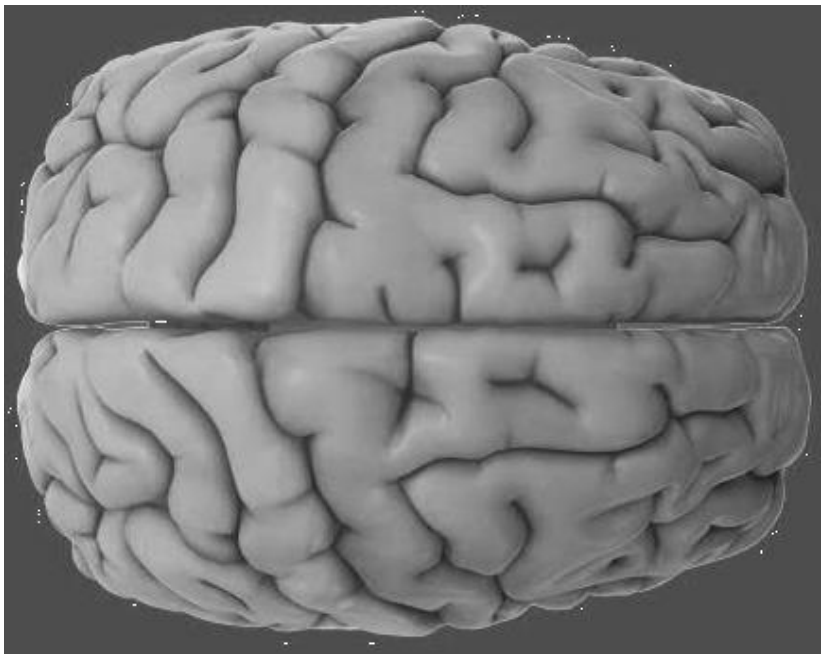
The l**ongitudinal fissure** separates the left from the right hemisphere. The **central sulcus** separates the frontal from parietal lobe. In front of the central sulcus, **the precentral gyrus** is located, while the **postcentral gyrus** lies behind it.

TASK 7: Indicate as follows in the image below and connect the boxes with the right parts:

- the **front of the brain** by marking one of the checkboxes
- the **longitudinal fissure** in green
- the **central sulcus** in blue
- the **precentral gyrus** in red
- the **postcentral gyrus** in yellow

Brain Tutor: select Gyri or Sulci; in the Areas list all gyri and sulci are listed

Front? ☐



Front? ☐

Longitudinal fissure

Central sulcus

Precentral gyrus

Postcentral gyrus

Often the name of the gyrus or sulcus refers to the location of it.

TASK 8: Have a look again at the terms of the directions at page 4 and try to indicate the following gyri and sulci in the image below:

- **lateral fissure** (or sulcus) in red
- **superior temporal gyrus** in blue
- **middle temporal gyrus** in yellow
- **inferior frontal gyrus** in green

Subsequently, write down these brain parts in the text boxes below and connect the boxes to the corresponding parts in the image.

QUESTIONS 2:

Which sulcus lies in between the precentral and postcentral gyrus? **The**…….**Sulcus**

Which gyrus lies posterior of the inferior frontal gyrus? **The**……**Gyrus**

Which lobes are separated most by the lateral fissure? **The**……...…...**&**……..…...**Lobe**

2.3 Functional areas in the cortex

The cortex of the brain can also be divided into functional areas: the **sensory** areas, the **motor** areas and the **association** areas.

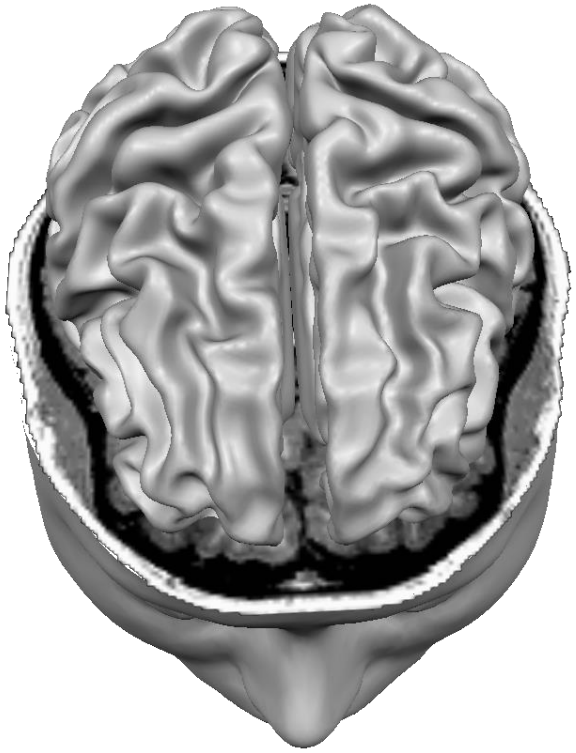
The precentral gyrus contains the **primary motor cortex**. In front of the primary cortex are the secondary motor cortex areas: the **supplementary motor area** (SMA) and the **pre-motor area** (PMA). The postcentral gyrus contains the **primary somatosensory cortex**.

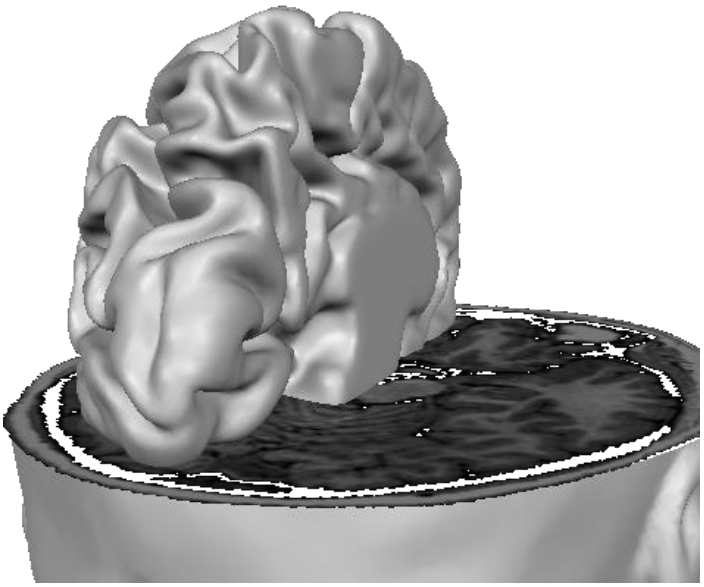
The occipital lobe is involved in visual perception. The **primary** and **secondary visual cortex** (Brodmann area 17 and 18) are located directly against and within the longitudinal fissure.

TASK 9: In the left picture indicate the **supplementary motor area** in blue, the **pre-motor area** in green, and the **primary somatosensory cortex** in red. Subsequently, write down these brain parts in the text boxes below and connect the boxes to the corresponding parts in the image.
Brain Tutor: use the fMRI icon to locate PMA and SMA

In the right picture, indicate the **primary visual cortex** in red and the **secondary visual cortex** in blue. Subsequently, write down these brain parts in the text boxes below and connect the boxes to the corresponding parts in the image.

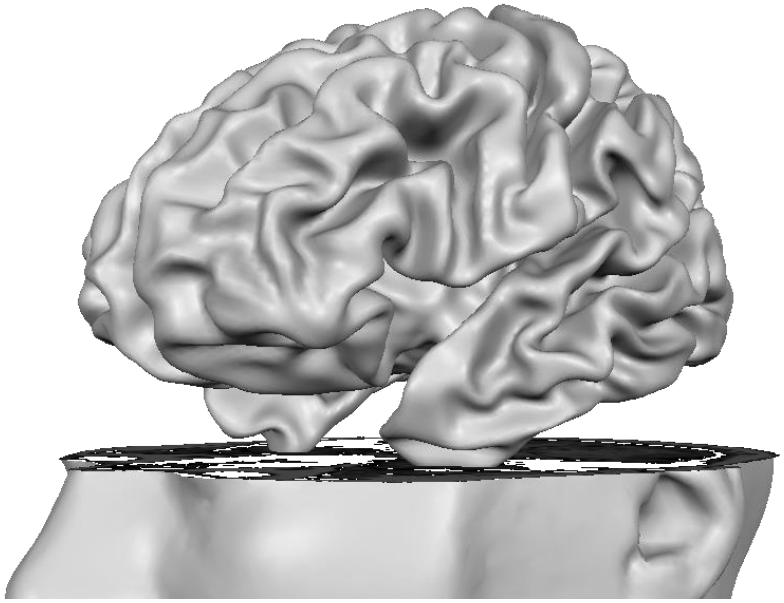
Brain Tutor: You can find these using the Brodmann icon





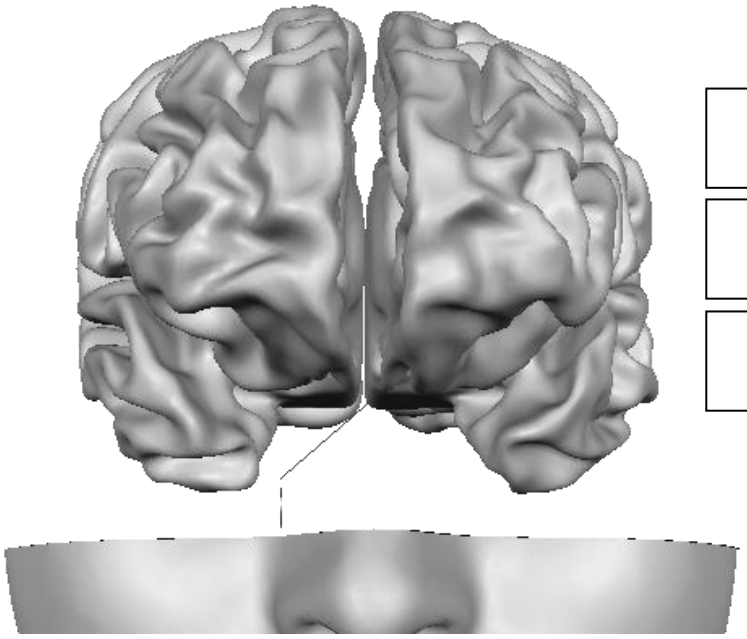
Broca's area is related to speech production and is located in the inferior frontal gyrus.

TASK 10: indicate **Broca's area** in red.
Brain Tutor: Use the fMRI icon, to locate this region



The **prefrontal** cortex is the anterior part of the frontal cortex. In the prefrontal cortex, right above the lateral fissure and below the frontal lobe is the **orbitofrontal cortex,** which is connected to the limbic system**.**
Along the **longitudinal fissure** is the **medial prefrontal cortex**.

TASK 11: Indicate the **orbitofrontal cortex** in red, **medial prefrontal cortex** in blue and **dorsolateral prefrontal cortex** in green. Subsequently, write down these brain parts in the text boxes below and connect the boxes to the corresponding parts in the image.
Select prefrontal cortex in G2C to find the dorsolateral and medial prefrontal cortex.

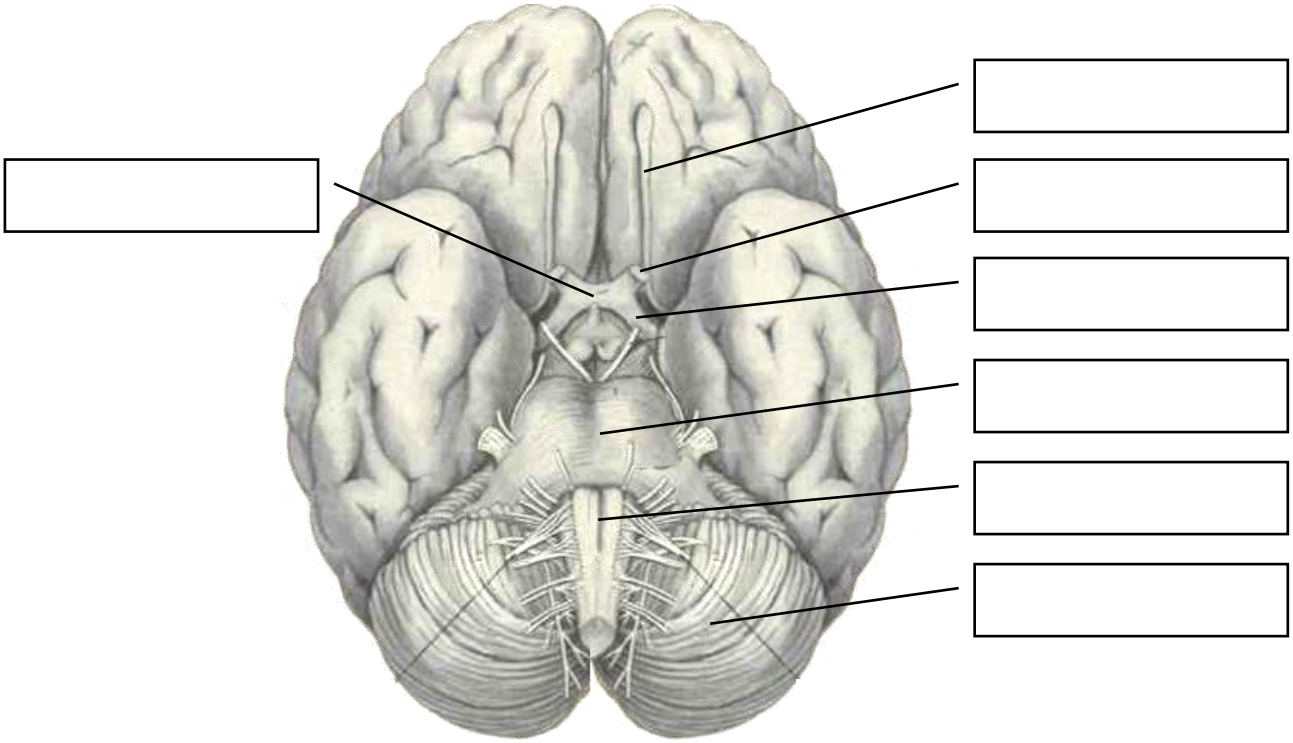


2.4 Tracts and nerves

A **tract** is a collection of nerve fibers (axons) in the central nervous system. A **nerve** is a collection of nerve fibers in the peripheral nervous system.

The **olfactory tract** is the pathway involved in the perception of odors. Posterior of the olfactory tract is the **optic chiasm** located; it is the site where the **optic nerve** changes into the **optic tract**.

TASK 12: Fill out the text boxes below with the right tracts and nerves. Furthermore, indicate the **olfactory tract** in green, the **optic chiasm** in red, the **optic nerve** in blue and the **optic tract** in yellow.
This is not shown in G2C or Brain Tutor. You will need to look this up in an anatomy book



2.5 Cerebellum and brain stem

The **cerebellum** has the appearance of a separate structure attached to the brain. It is involved in motor control. The **brain stem** is the posterior part of the brain, and consists of the **pons** and **medulla.**

TASK 13: Fill out the remaining text boxes above and indicate the **cerebellum** in green, the **pons** in red and the **medulla** in blue

3. Inside the brain

3.1. WATCH CLIPS 3 AND 4 IN THE PRACTICAL FOLDER IN ELEUM

These clips will provide an overview and help you complete the tasks in this part of the practical.

3.2. Major structures of the brain

The **basal ganglia** is a group of nuclei located in the telencephalon. It consists of the **amygdala**, **striatum** (caudate and putamen), and the **globus pallidus**.
The diencephalon is composed of 2 large structures; the **thalamus** and the **hypothalamus.** The thalamus is a large two-lobed structure and consists of different pairs of nuclei. The hypothalamus is located just below the anterior thalamus (*hypo means below).* It regulates the release of hormones from the **pituitary gland**. The **mammilary bodies** are often considered to be part of the hypothalamus. They are located on the inferior surface of the hypothalamus just behind the pituitary.
The **hippocampus** *(meaning 'seahorse')* is located between the thalamus and the cortex. The **fornix** is a bundle of tracts which links the hippocampus with the hypothalamus and other structures.
The mesencephalon has two divisions; the **tectum** and the **tegmentum**. The tectum is composed of two bumps; the **superior** and **inferior colliculus**

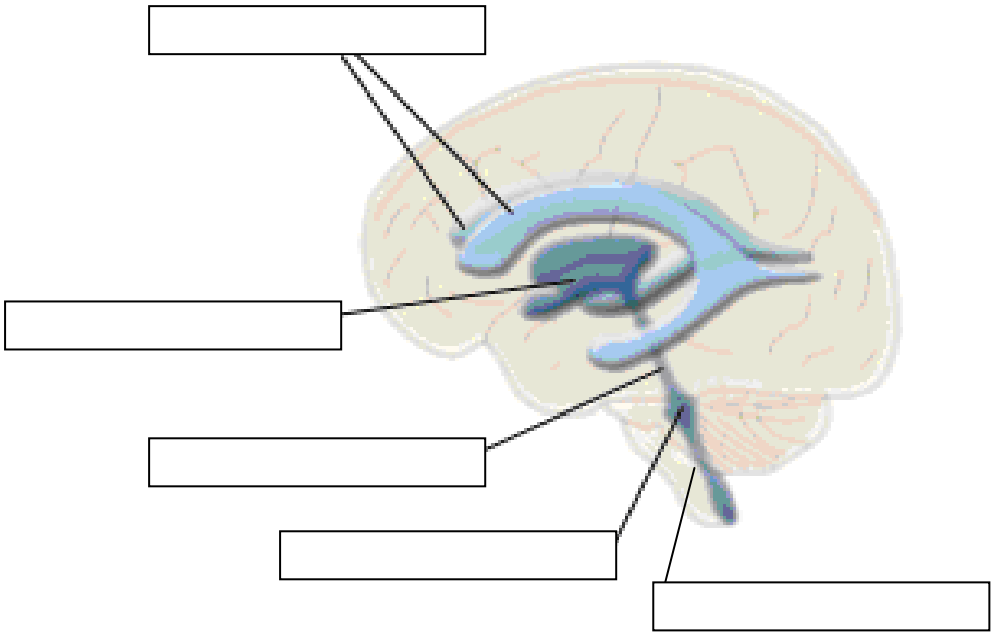
3.2 The cerebral commissures

The two hemispheres are connected to one another by a few large tracts. These tracts are called cerebral commissures. The largest cerebral commissure is the **corpus callosum**. Two other noteworthy commissures are the **anterior commissure,** which connects the temporal lobes and the **massa intermedia,** which joins the two lobes of the thalamus.
Right above the corpus callosum, the **cingulate gyrus** is located, which is part of the limbic system.

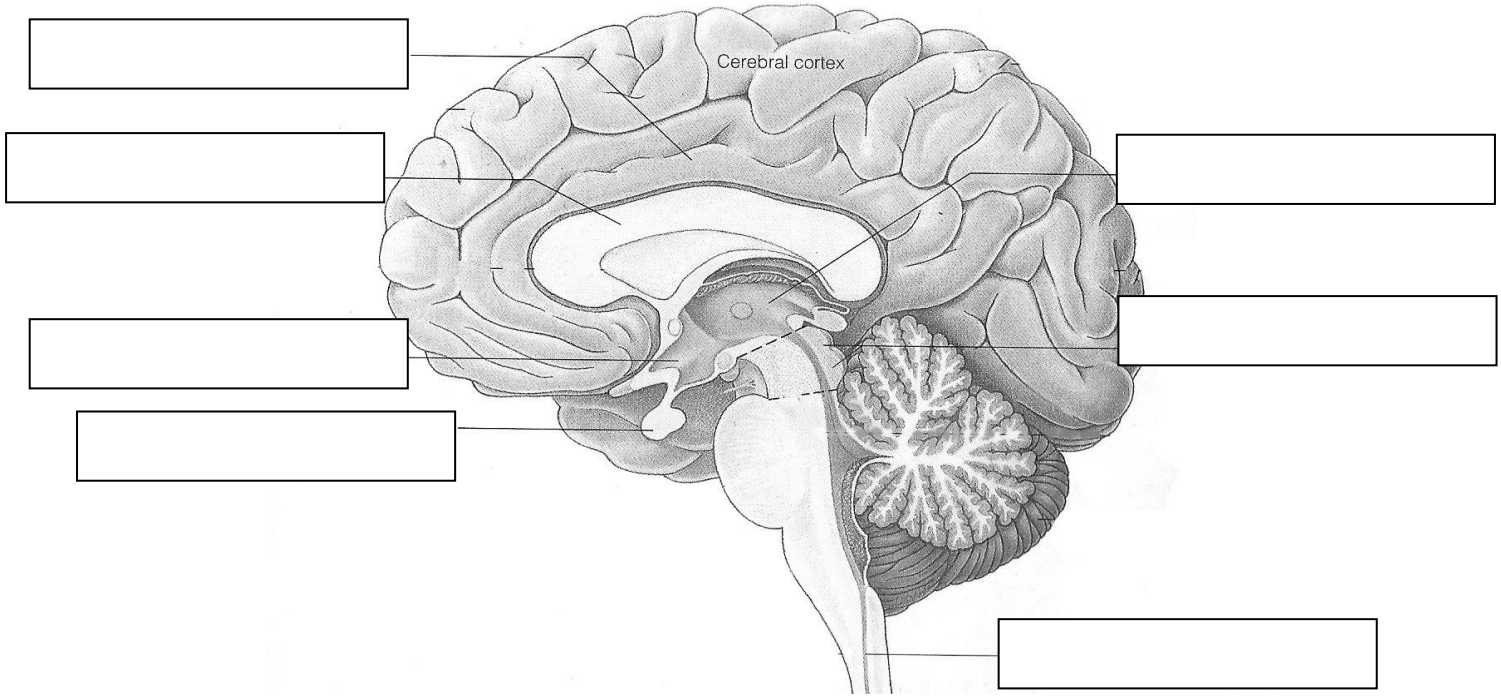
3.3 The cerebral ventricles

The ventricular system contains the cerebrospinal fluid in the brain. It includes the central canal **which changes into the** fourth ventricle**. The fourth ventricle is narrowed into the** cerebral aquaduct **which changes into the** third ventricle. **The third ventricle continues to form the paired lateral ventricles.**

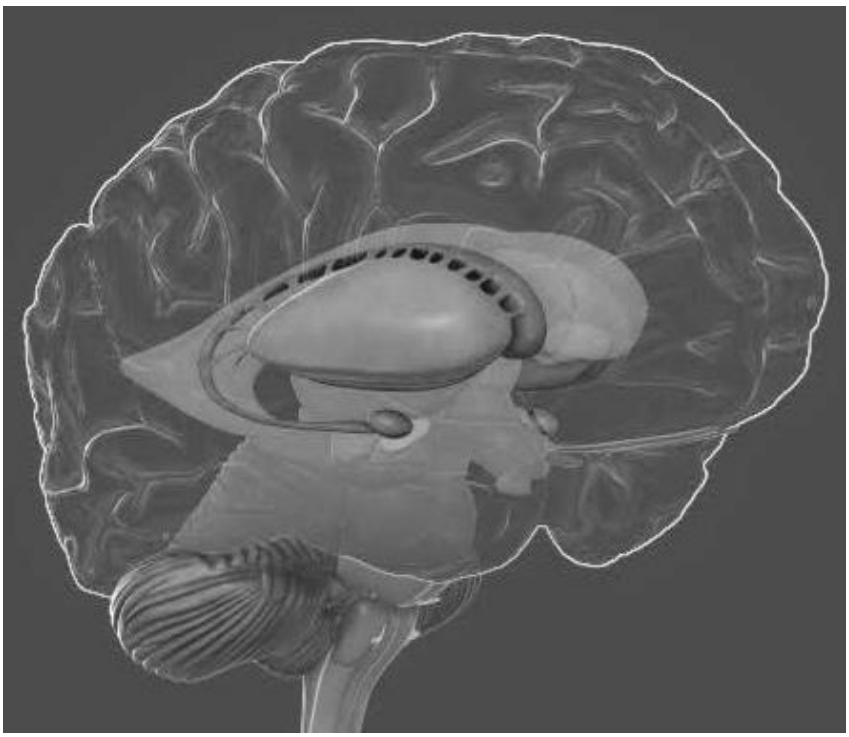
TASK 14: Fill out the different subparts of the ventricle system.



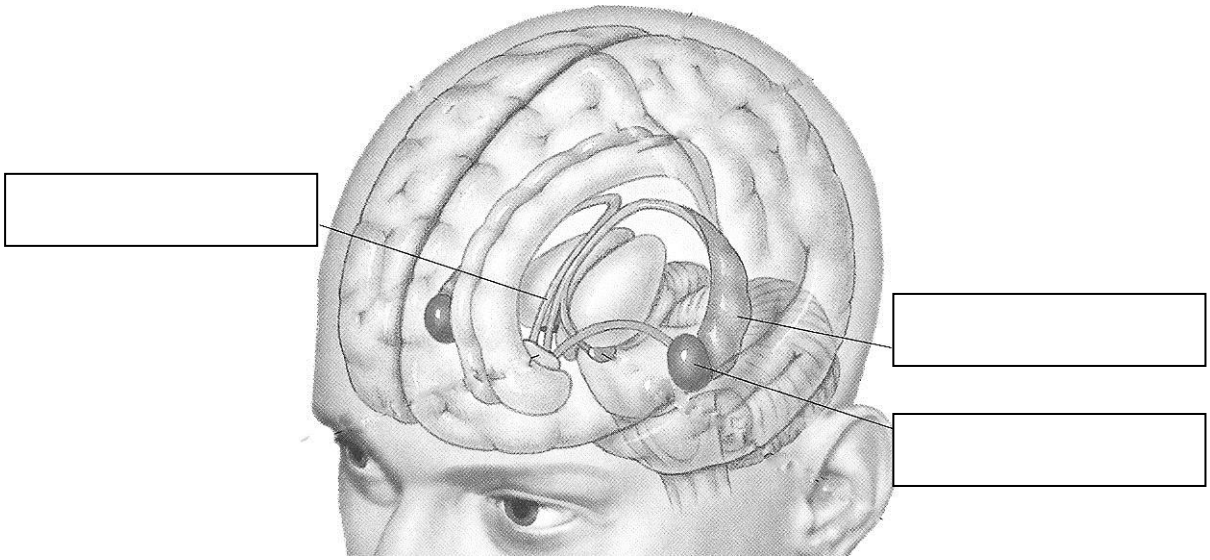
TASK 15: Indicate the **thalamus**, **hypothalamus**, **pituitary gland**, **superior colliculus**, **cingulate gyrus**, **corpus callosum** and **central canal**



TASK 16: Indicate the **amygdala** in yellow, the **putamen** in red, the **globus pallidus** in green and the **caudate** in blue. Subsequently, write down these brain parts in the text boxes below and connect the boxes to the corresponding parts in the image.



TASK 17: Indicate the hippocampus, fornix and amygdala



QUESTIONS 3:

Which structure is joined by the massa intermedia? ……

Which ventricle surrounds the thalamus? ……

Which structure connects the mammillary body with the hippocampus?…….

Which structures does the telencephalon include? …….

Which structures are part of the diencephalon? ……..

Which structures are included in the metencephalon? …….

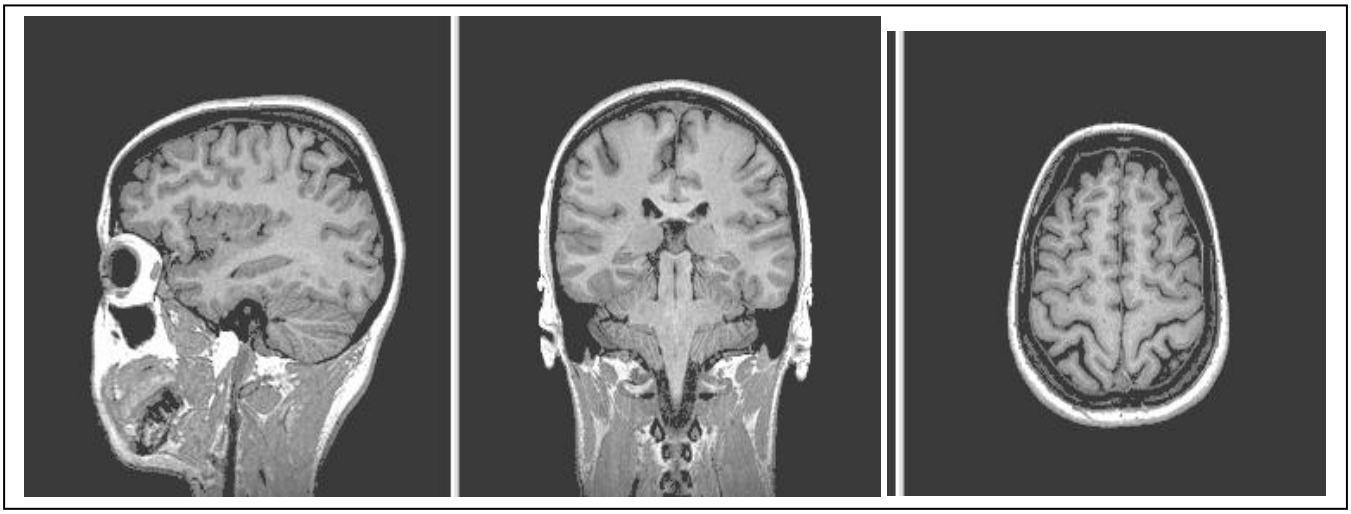
3.3 Exploring MRI pictures

Using the Volume View of Brain Tutor, you can move around the three dimensions of MRI scans.

The **talairach coordinates** indicate the location on the x-, y- and z-axis of a selected point (*The Talairach coordinate system is used to describe the location of brain structures independent of individual differences in size and shape).*

TASK 18: Write down the orientation of each section above the pictures. Indicate the **cerebellum**, **corpus callosum**, **brain stem**, **longitudinal fissure** and **lateral ventricles**.

QUESTION 4: Why are these structures not visible on all three sections?



Cerebellum

Corpus callosum

Brain stem

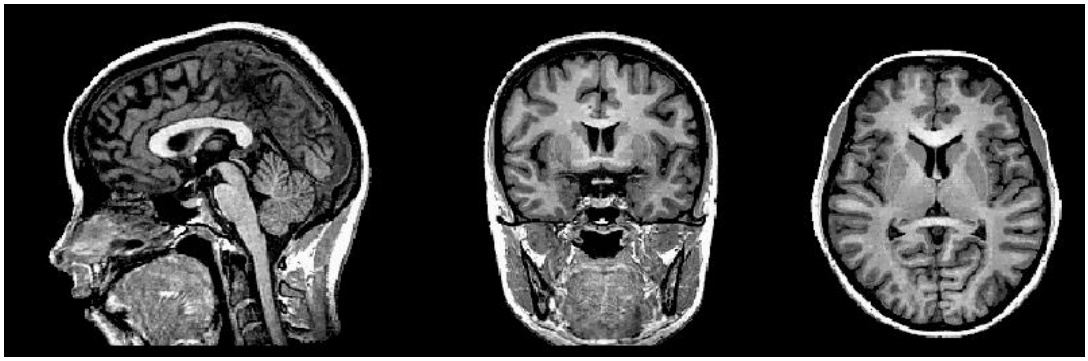
Longitudinal fissure

Lateral ventricles

TASK 19: Locate the **SMA** in panel 1 and 2 and color it red. In panel 3, indicate **hMT+** in green and **Brodman Area 17 (BA17)** in blue.

1. Talairach coordinates x=0, y=0, z=0

2. Talairach coordinates x=0, y=0, z=50



3. Talairach coordinates x=0, Y=0, z=8

QUESTIONS 5: Why is the SMA not visible in all 3 slices of the 1st panel?

……...

The visual areas are also named V1, V2, V3, V4 and V5. Which are the synonyms for BA17 and hMT+?

……...