GUIDELINES ON PLAGIARISM

Plagiarism is "the taking and using as one's own of the thoughts, writings or inventions of another". These thoughts or writings could be, for example, from a book or the internet or from the work of another student.

Like the scientific process, assessment of students at university relies upon the integrity of the participants. The Department expects that any piece of work submitted by a student for assessment will be essentially their own work, and that the contributions of others to that work will be appropriately acknowledged. In essence, all students are expected to write their own essays and assignments, just as they are expected to sit the exams themselves.

Students should generally avoid verbatim copying of published work, even when the work is cited. They are strongly encouraged to express their knowledge and thoughts in their own words, rather than those of others, because this greatly assists the learning process. However, it is acknowledged that in some circumstances it is desirable to quote directly from a published work.

Plagiarism is a very serious offence that carries substantial penalties. If a student is found to have committed plagiarism, the student may receive a failing grade for the work in question and the Department may recommend the matter be dealt with under University Statute 17 (Misconduct). The student may be excluded from the unit. These guidelines are not intended, in any sense, to discourage students from discussing their views with other students, staff or others outside the university. Indeed this is strongly encouraged as it is one of the very best ways of learning.

Any student who does not fully understand these guidelines or who experiences difficulties in following them should consult their tutor or unit coordinator.


5 March 1999

Student Staff Meeting

A meeting between student representatives from all the ANHB units with staff will be held in September. This is a chance for you to express any comments about the course. Constructive criticism is always welcomed. There may be a preliminary meeting beforehand so that you can communicate with the class reps. before the meeting.
3.

A. Draw a diagram of the pathway for two point discriminatory touch and proprioception

B. (4 marks)

Describe the location of the cortical areas dealing with audition

i. ________________________________

ii. ________________________________

iii. ________________________________

iv. ________________________________

v. ________________________________

vi. ________________________________ (3 marks)

C. Name the pure motor cranial nerves and the groups of muscles they innervate.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ (3 marks)

4.

Write a one page essay on the control of movement.
2.

A. Discuss the role of the pharyngeal arches in cranial nerve formation.

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(5 marks)

B. Name the four sorts of fibres in the facial nerve and where they come from/go to

__________________________________________________________

__________________________________________________________

__________________________________________________________

(2 Marks)

C. What are the common causes of spina bifida?

__________________________________________________________

__________________________________________________________

(2 marks)

D. Why is a lumbar puncture carried out where it is?

__________________________________________________________

(1 mark)
It is expected that to illustrate many of your answers you will draw on the pages opposite

1.

A. Describe the ventricles of the brain (use a diagram if necessary)

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(5 marks)

B. Describe the three main types of glial cell

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(4 marks)

C. Draw the arterial supply of the cerebral cortex

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(4 marks)
The University of Western Australia

Final Examination                                   November 1999

Department of Anatomy and Human Biology

SURNAME: ______________________ STUDENT NO:___________________________
GIVEN NAMES: ________________________________ FACULTY: _________________

Human Neuroanatomy 207  910.207

EXAMPLE ONLY

This paper contains:
12 Questions
13 pages
Total marks 120

Time Allowed: 3 hours
Reading time: 10 minutes

Examiners use only

<table>
<thead>
<tr>
<th>Question</th>
<th>MARK /10</th>
<th>Comments</th>
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Total /120
Outcomes

Aims of the Course

- To gain a basic vocabulary in neuroanatomy
- To learn the basic "geography" of the CNS
- To have an internal concept of the way the CNS is laid out (tested in practicals)
- To have an overview of the way this structure is related to function
- To prepare you for third year neuroscience courses
- To interest you in neuroscience
- To contribute as a "scientifically" educated citizen to debates about neuroscience issues

Assessment

Exams

*Formative* (to help you learn and should match the objectives)
*Summative* (to measure your ability, a hurdle to pass)

All exams have some of both aspects but the in course assessments will only count a small amount towards your final mark, they are formative. The final exam gives you your mark, it is used to allow you in to further units, it is summative.

Examination Format

*In course assessment*
Weekly tests on the material in each week’s lab. (Given out at end of lab).
MCQs/Self marking practical exam Week 6

*Final Exam*
A mix of MCQs, short answer questions, diagrams to label, short essays from a wide choice.

*Practical exam*
The Practical exams consist of specimens with questions nearby, the questions may simply relate to a structure "name A" or may be functionally related "what does A do? What happens if A is cut?) or may involve more theoretical knowledge and understanding (why does X happen if A is cut?). The specimens can consist of any material you have seen during the semester, X-rays, bones, brains etc. There is a “practice” exam in mid semester to give you a feel for the exam without too many marks at stake. Questions WILL be about function as well as structure and names.

The final mark is derived from
1. In course “Practice” prac test wk. 6, based on work to that point 5%
2. Final practical exam at end of semester 35%
3. Final written exam 60%
12. **LABORATORY 12**  
Free - available for individual revision sessions.

13. **LABORATORY 13**  
Class revision, test questions and video.
Somato Sensory Systems

In this lab we identify components of various sensory pathways in brain specimens, models and illustrations. A considerable part of this lab is an exercise. Revise the features studied earlier and correlate them with the anatomy of the sensory pathways, adding new features as you go along. Remember that in the lab we focus on structures seen with the unaided eye. You will need to supplement lab work with theoretical knowledge.

Somatosensory System

In pictures of cross sections (these are photomicrographs from actual slides) of spinal cord, identify

• Ventral, lateral and dorsal white funiculi.

Which tracts carry sensations of touch, pain and temperature? Where are they located? Are they crossed tracts or uncrossed?

What are the tracts in the dorsal funiculus? Do both these tracts traverse the entire length of the spinal cord?

What is somatotopism?

• In the medulla oblongata (specimen/model and cross sections) identify the gracile and cuneate tubercles.

What is the function of the nuclei underlying these tubercles?

• On a cross section of the medulla oblongata identify the internal arcuate fibres. What is their rostral continuation?

Where do somatosensory fibres terminate in the thalamus? Which special sensory fibres also terminate in the same nucleus?

• In a horizontal section of the brain identify the parts of the internal capsule. Which part carries somatosensory thalamocortical fibres?

Which artery/arteries supply blood to the internal capsule?

• In a half brain identify the somatosensory areas.

Which lobe do they belong to? What is the arterial supply of these areas?
Slide 27  High pons - superior cerebellar peduncles, medial longitudinal fasciculus, lateral lemniscus (solochrome)

Slide 28  As for 27 (CV)

Slide 29  Midbrain at level of inferior colliculus (solochrome)

Slide 30  As for 29 (CV)

Slide 31  Midbrain at level of superior colliculus - red nucleus (some CV, LFB: some solochrome)

Slide 32  As for 31 (CV)

**Further slides** - through diencephalon, hippocampus, cerebellum and cerebrum.

Slide 33  Section through thalamus, hypothalamus, epithalamus (some CV, LFB; some solochrome)

Slide 34  As for 33 (CV)

Slide 38  Section through hippocampal complex (CV)

Slide 39  As for 38 (solochrome)

Slide 40  Section through amygdala (CV)

Slide 41  Section through cerebellum (solochrome)

Slide 42  As for 41 (CV)

Slide 43  Section through pre- and postcentral gyri (solochrome)

Slide 44  As for 43 (CV)

Slide 45  Section through visual cortex (solochrome)

Slide 46  As for 45 (CV)
11.1.5 Midbrain - superior colliculus

superior colliculus
spinothalamic tracts
medial lemniscus
cerebral aqueduct
central grey substance
red nucleus
oculomotor nucleus
medial longitudinal fasciculus
fibres of III nerve
substantia nigra
cerebral peduncles
interpeduncular fossa

SLIDES

Slide 23 Low pons - middle and inferior cerebellar peduncles, corticobulbar and pontocerebellar fibres (solochrome)

Slide 24 As for 23 (CV)

Slide 25 Pons at level of facial colliculus (solochrome)

Slide 26 As for 25 (CV)
11.1.4 Midbrain - inferior colliculus

inferior colliculus
brachium of inferior colliculus
medial longitudinal fasciculus
trochlear nucleus
reticular formation
cerebral aqueduct
central grey substance
superior cerebellar peduncles
substantia nigra
cerebral peduncles
interpeduncular fossa
11. **LABORATORY 11**  
Sections of human nervous tissue

**EXAMINATION OF HUMAN TISSUE SECTIONS**

11.1 *Cross sections through brainstem (cont’d)*

### 11.1.1 Lower/middle pons

- middle cerebellar peduncle
- fourth ventricle
- medial longitudinal fasciculus
- medial lemniscus
- pontine nuclei
- pyramidal tract
- fibres of VIII
- position of genu of VII
- position of dentate nucleus
- reticular formation

### 11.1.2 Middle pons

- middle cerebellar peduncle
- fourth ventricle
- medial longitudinal fasciculus
- motor nucleus of V
- principal sensory nucleus of V
- medial lemniscus
- spinothalamic tracts
- reticular formation
- pyramidal tract and corticopontine fibres
- pontine nuclei

### 11.1.3 Midbrain - caudal inferior colliculus

- brachium of inferior colliculus
- lateral lemniscus
- spinothalamic tracts
- medial lemniscus
- medial longitudinal fasciculus
- trochlear nucleus (IV)
- cerebral aqueduct
- central grey substance
- decussation of superior cerebellar peduncles
- substantia nigra
SLIDES

Slide 1  Sacral region - spinal cord  
          (cresyl violet and luxol fast blue)

Slide 3  Lumbar region - spinal cord  
          (CV, LFB)

Slide 5  Mid-thoracic region - spinal cord  
          (CV, LFB)

Slide 7  High-thoracic region - spinal cord  
          (CV, LFB)

Slide 9  Cervical enlargement - spinal cord  
          (CV, LFB)

Slide 11 High cervical region - spinal cord  
          (CV, LFB)

Slide 13 Junction of spinal cord and medulla; pyramidal decussation  
          (CV, LFB)

Slide 15 Very low medulla - spinal tract of V, cuneate nucleus  
          (CV, LFB; some are solochrome stain)

Slide 17 Low medulla - gracile and cuneate tubercles, medial lemniscus,  
          beginning of olive  
          (some CV, LFB; some solochrome)

Slide 18 As for 17 (CV)

Slide 19 Closed medulla - olives, central grey  
          (most solochrome; some CV, LFB)

Slide 20 As for 19 (CV)

Slide 21 Open medulla  
          (most solochrome; some CV, LFB)

Slide 22 As for 21 (CV)
10.2.2 Upper medulla - just above obex

fourth ventricle
inferior olivary nucleus
pyramidal tract
fasciculus and nucleus cuneatus
medial lemniscus
hypoglossal nucleus
dorsal (motor) nucleus of X
solitary nucleus and tract
position of reticular formation
medial longitudinal fasciculus
nucleus of spinal tract of V

10.2.3 Upper medulla

fourth ventricle
hypoglossal nucleus and fibres
dorsal (motor) nucleus of X and fibres
nucleus of solitary tract
position of vestibular nuclei
inferior cerebellar peduncle
medial longitudinal fasciculus
pyramidal tract
reticular formation
nucleus of spinal tract of V
inferior olivary nucleus

10.2.4 Medulla-pons

cerebellar folia
fourth ventricle
inferior olivary nucleus
pyramidal tract
medial longitudinal fasciculus
facial colliculus
position of abducens nucleus
fibres of VI
fibres of VII
fibres of VIII
nucleus of spinal tract of V
position of nucleus of VII
Transverse section of the caudal medulla at the level of the decussation of the medial lemniscus. The internal arcuate fibers decussate and form the medial lemniscus. CTG = Cuneate (arm), Trunk, and Gracile (leg) components of the medial lemniscus. General somatic afferent (GSA) fibers of the vagal nerve (CN X) enter the spinal trigeminal tract of CN V (arrow).

Fastigial nucleus
Globose nucleus

Sulcus limitans

Transverse section of the medulla at the midolivary level. The vagal (CN X), hypoglossal (CN XII), and vestibular (CN VIII) nerves are prominent in this section. The nucleus ambiguus gives rise to special visceral efferent (SVE) fibers to CN IX, CN X, and CN XI. The dorsal spinocerebellar tract is in the interior cerebellar peduncle.

Corticospinal tracts

Caudal pons at the level of the abducent (CN VI) and facial (CN VII) nuclei. Note that the intra-axial abducent fibers pass through the medial lemniscus and the descending corticospinal fibers. Note the looping course of the intra-axial facial nerve fibers that exit the brainstem in the cerebellopontine sulcus. The four cerebellar nuclei overlie the fourth ventricle. Note also the looping course of the facial nerve fibers.
The following lists give you an idea of the main structures to look for at various levels through the spinal cord and brainstem.

10.1 Cross sections through spinal cord

10.1.1 Sacral/lumbar region

- anterior funiculus
- posterior funiculus (fasciculus gracilis)
- lateral funiculus
- ventral (anterior) horn
- dorsal (posterior) horn
- substantia gelatinosa
- approximate positions of: lateral corticospinal tract, spinothalamic tract

10.1.2 Thoracic/cervical region

- fasciculus gracilis
- fasciculus cuneatus
- ventral (anterior) horn
- lateral horn
- dorsal (posterior) horn
- approximate positions of: spinothalamic tract, spinocerebellar tracts, ventral and lateral corticospinal tracts

10.2 Cross sections through brainstem

10.2.1 Lower medulla - medial lemniscus

- nucleus gracilis
- nucleus cuneatus
- nucleus of spinal tract of V
- pyramidal tract
- internal arcuate fibres
- medial lemniscus
- positions of solitary nucleus, dorsal motor nucleus of X, hypoglossal nucleus (XII)
- approximate positions of spinocerebellar tracts, spinothalamic tract
EXAMINATION OF HUMAN TISSUE SECTIONS

Work through your microscope slides and identify as closely as possible the named structures. Where tracts are concerned, you will be able to say only \textit{approximately} where they are located. The object of this exercise is to help you integrate information gained from the lectures and previous laboratory classes. Try and \textit{understand} the organization of the major systems, \textit{rather than simply memorize} where discrete structures are found.

Always commence the examination of a slide by studying it with the naked eye. Once you have identified as much as possible in this way, proceed with the examination using a hand magnifying lens.

It may be helpful to draw an outline of each section and indicate the approximate location of the named tracts and grey matter structures.

Remember that the sections you have may not correspond exactly to text-book diagrams or photographs. This is because a slight difference in the level of a section will affect its composition. Similarly numbered slides will also vary in their precise levels.

\textbf{HINTS:}

Try first of all to work out at what level the section is taken

- The shape of the ventricles should help here
  - In the diencephalon, a narrow vertical slit (the third ventricle)
  - In the midbrain, a narrow tube (the cerebral aqueduct)
  - In the open medulla, a large opening dorsally (the fourth ventricle)
  - In the myelencephalon a minute central canal (as in the spinal cord)

Remember the nerves go roughly from 1 rostrally to 12 caudally so that if you have a rough idea at what level the section is taken it may help you to identify cranial nerves and their nuclei. \textbf{Revise} the components the various nerves have (motor/sensory/visceral/somatic). If identifying cranial nerves \textbf{revise} the basic layout of sensory and motor areas.
Identify the **optic radiations**, fibres in the posterior part of the internal capsule projecting from the LGB to the striate cortex.

### 9.2 Motor system

#### 9.2.1. Corticospinal pathways:

(i) Define "primary motor cortex", that is, the pre-central gyrus. Which parts of this produce movements of the foot? What is the arterial supply of the 'foot' area of cortex?

(ii) On the coronal section which passes through the basal ganglia identify the fibres of:

- the corona radiata converging towards the **internal capsule** from the cortex.

(iii) By examination of the coronal brain slices establish the nature of the relationship between fibres of:

- the internal capsule and cerebral peduncles;
- the cerebral peduncles and pyramids.

(iv) Find again the decussation of the pyramids.

#### 9.2.2 Indirect corticospinal ("extrapyramidal") pathways:

Trace on the horizontal and coronal brain slices:

(i) **precentral gyrus**

(ii) **corona radiata**

(iii) **head of the caudate and putamen**

(iv) **globus pallidus**

---

**OPTIC PATHWAY**

**VISUAL FIELD DEFECTS**

*Fig. 11.6 Visual field defects in lesions of the visual pathway*
9. **LABORATORY 9**  
*Horizontal and coronal slices, half brains*

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<th>ANATOMY OF VISUAL, AUDITORY AND MOTOR SYSTEMS</th>
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9.1. **Visual system and auditory systems**

Using the lower half of the horizontally cut slice of cerebral hemisphere, re-examine on the inferior surface and identify the following:

(i) **optic nerve**

(ii) **optic chiasm**

(iii) **optic tract** - follow this to the -

(iv) **lateral geniculate body** (LGB), lying below the pulvinar

The lateral geniculate body (nucleus) can be located by tracing the optic tract posteriorly. Axons from the retinæ course in the optic nerve and optic tract and in humans the majority terminate in the LGB.

**REVIEW** the decussation patterns at the optic chiasm, and the deficits that occur after injury to the optic nerve, optic chiasm or optic tract.

(v) More medially, find the eminence of the **medial geniculate body** (MGB) (nucleus) on the posterior thalamus.

In which direction is the **inferior colliculus**, relative to the medial geniculate body?

Locate the **brachium of the inferior colliculus** connecting the two structures. Ascending auditory fibres enter the inferior colliculus via the lateral lemniscus.

(vi) Find the **brachium of the superior colliculus**, a ridge extending between the LGB and the superior colliculus in continuity with the optic tract.

(vii) Note the position of the **superior colliculus** relative to the LGB.

(viii) Locate once again the **pretectal area** and **posterior commissure**.

**DRAW** circuit diagrams that show the relationships between:

(i) Retina, LGB, superior colliculus, and primary visual cortex (area 17)

(ii) Ascending auditory pathways, inferior colliculus, MGB, and primary auditory cortex (area 41, 42)

In the horizontal and coronal slices, re-define the visual cortex. Can you detect the striation of the visual cortex by the **white line of Gennari**?
Using the series of horizontal and coronal slices and with additional reference to the half brains that you looked at last week, REVIEW the organization and structure of the ventricular system.

**third ventricle**
**fornix**
**hypothalamus**
**hippocampus**
**dentate gyrus**
**lateral geniculate body**
**optic radiation**

**Figure 2.9** Thalamus and corpus striatum, seen upon removal of the trunk of the corpus callosum and the body of the fornix.
The internal capsule is the main pathway interconnecting the cortex and the internal grey matter of the cerebrum, as well as the great efferent pathway between the cerebrum and lower centres. The best known efferent constituents are the corticobulbar, corticopontine and corticospinal tracts, which control motor neurons emerging from the brain stem (from the bulbar nuclei of the cranial nerves) and spinal cord.

The basal ganglia comprise the caudate nucleus, lentiform nucleus, amygdala and claustrum. Try to envisage the three dimensional relationships of these structures and their relationship to the ventricles, internal capsule and thalamus. The internal capsule has a posterior limb between the thalamus and the lentiform nucleus, and an anterior limb between the caudate nucleus and the lentiform nucleus. The lentiform nucleus has an outer lamina, the putamen, which is continuous inferiorly with the caudate nucleus. The inner or more medial part, usually seen as two zones in relation to the genu of the internal capsule is called the globus pallidus, since it is paler than other grey masses in the cerebrum. Lateral to the putamen is a narrow band of white matter, the external capsule, which separates the putamen from a narrow grey band, the claustrum, lateral to which is the extreme capsule. Lateral to the extreme capsule is the insular cortex.

The caudate nucleus is a comma, or tadpole (caudate = "tailed") shaped structure which narrows posteriorly and maintains a relationship to the lateral ventricle in its whole extent. Its head is in the inferolateral wall of the anterior horn; its body is in the floor of the body of the ventricle and its tail lies in the roof of the inferior (descending) horn, where it is considerably attenuated before it expands again near the amygdaloid body.

Explore the inferior horn of the lateral ventricle which curves down and forwards from the posterior end of the body of the ventricle. Expose it from the medial side. The choroid plexus is here an invagination into the medial wall of the inferior horn. The floor is the hippocampus, the lateral wall is the white matter of the temporal lobe, and in the roof is the tail of the caudate nucleus, which terminates in the amygdaloid body superior to the uncus.

Follow the hippocampus, and describe its form and location. Note the dentate gyrus and parts of the fornix. The fimbrium, a glistening mass of fibres, can be seen forming a medial boundary to the choroid fissure. How does the fimbrium relate to the fornix?

8.2 Coronal slices

On the series of coronal slices, identify as many of the following structures as possible:

- corpus callosum
- caudate nucleus (head and tail)
- internal capsule (anterior and posterior limbs)
- putamen
- globus pallidus
- external capsule
- extreme capsule
- claustrum
- insula
- lateral ventricle (anterior and posterior horns, body)
- anterior commissure
- amygdaloid body
- optic tract
HORIZONTAL (Axial) AND CORONAL SLICES

8.1 Horizontal slices (Clinically, as in a CAT scan, referred to as an Axial section) These slices go gradually inferior starting from the superior dorsal surface

8.1.1 First slice: This slice is cut through the left hemisphere at the level of the surface of the corpus callosum.

Grey and white matter: The complexity of the cortical foldings is exposed and you will see some of the variations in the thickness of the cortical grey matter. The white matter is also exposed, this consists of nerve fibres running in many different directions; broadly these are of three kinds:

(i) fibres connecting the cortex with the central grey masses such as the thalamus and basal ganglia;

(ii) fibres running between the cortex and structures below the cerebral hemispheres, e.g. in the brainstem.

(iii) fibres either joining different parts of the cerebral cortex of the same side (association fibres) or linking up the cortex of one hemisphere with that of the other by way of the commissures, particularly through the great commissure, the corpus callosum, or the smaller anterior and posterior commisures.

8.1.2. Second slice:

Lateral ventricle: With the second slice you are now in a position to review the organization of the lateral ventricle. The anterior horn is in front of the interventricular foramen. It extends downwards and forwards and is widest near its roof. The septum pelucidum separates the anterior horns of the two sides. The head of the caudate nucleus bulges into the ventricle.

The body of the lateral ventricle lies posterior to the interventricular foramen. The floor here is formed medially by the superior surface of the thalamus, whose anterior nucleus is marked by a bulge, and laterally by the narrowing tail of the caudate nucleus.

The posterior horn of the lateral ventricle is a variable elongation of the body back into the occipital lobes.

Compare these views with the casts of the ventricles provided.

8.1.3 Third slice: This third slice should pass approximately through the middle of the thalamus.

Examine the cut surfaces of the bottom half of the cut hemisphere, and identify the boundaries of the thalamus. Medially there is the third ventricle. Anterolaterally there is a prominent band of white matter, the internal capsule, which is a continuation of the cerebral peduncle.
(ii) central sulcus

(iii) parieto-occipital sulcus

(iv) calcarine fissure or sulcus

The portion posterior to the parieto-occipital sulcus is the visual cortex. Trace the calcarine fissure onto the lateral surface of the hemisphere.

(d) Fornix

(i) Identify the fornix, a fibre bundle slung beneath the corpus callosum in the inferior edge of the septum pellucidum.

(ii) Follow it anteriorly as it forms the anterior edge of the interventricular foramen. This part is the anterior column of the fornix. These fibres end in the mammillary bodies.

(e) Caudate nucleus. Identify the bulge of the caudate nucleus, forming the lateral wall of the lateral ventricle. Identify the parts of the caudate nucleus, namely:

(i) the large head anteriorly;

(ii) the body continuing posteriorly;

(iii) the tail curving down into the temporal lobe to terminate next to an enlargement, the amygdala, which underlies the uncus.
3rd ventricle. Trace the boundaries of the 3rd ventricle. Begin at the optic chiasm, the anterior limit of the floor of the ventricle, and proceed posteriorly past the hypophyseal stalk remnant to the mamillary bodies which lie at the posterior limit of the floor of the ventricle.

Posteriorly the third ventricle is continuous with the cerebral aqueduct. Identify the pineal body. Immediately subjacent to it, rostral to the superior colliculus, may be found the posterior commissure. Where does the splenium of the corpus callosum lie relative to the superior colliculi? The roof of the third ventricle extends almost horizontally forward to the interventricular foramen (Foramen of Monroe). Between the interventricular foramen superiorly and the optic chiasm inferiorly extends the rostral wall of the ventricle, the lamina terminalis. In the most superior part of the lamina terminalis, anterior to the interventricular foramen, find the anterior commissure.

Identify the following features of the lateral wall of the third ventricle:

(i) massa intermedia (interthalamic adhesion), interconnecting the halves of the thalamus. Is it grey or white matter?
(ii) hypothalamic sulcus, running posteriorly from the interventricular foramen, and separating the thalamus from the hypothalamus.

The septum pellucidum is slung beneath the corpus callosum and conceals the cavity of the lateral ventricle. In the intact brain it separates the cavities of the two hemispheres.

Using a blunt seeker carefully explore the extent of the ventricular system of the cerebral hemispheres. Locate:

(i) the anterior horn of the lateral ventricle extending rostrally into the frontal lobe,
(ii) the body of the lateral ventricle (that part visible beneath the corpus callosum)
(iii) the posterior horn extending into the occipital lobe
(iv) the inferior or temporal horn dropping down into the temporal lobe from the junction of the body and posterior horns.

These constituent parts of the lateral ventricles will be seen in horizontal sections through the cerebral hemispheres in the next practical class. Compare them to the casts of the ventricles provided for your interest.

7.2 Forebrain

Examine the medial surface of the hemisected brain.

(a) Identify the pulvinar on either side of the pineal. This prominence forms the posterior extremity of the thalamus.

(b) Preoptic region: The region lying between the temporal lobe and optic chiasm, anterior to the optic tract, is the preoptic region. It is identified externally by the anterior perforate substance. What causes the perforations? What is their origin?

(c) Cerebral hemispheres Identify the following gyri and sulci:

(i) cingulate gyrus and sulcus
7. LABORATORY 7

VENTRICULAR SYSTEM, EXAMINATION OF MEDIAL BRAIN SURFACE

7.1 Ventricular system

Early in development, the central nervous system is a simple tube of neuroepithelium, and its cavity has a fairly uniform diameter throughout its length. After the telecephalic vesicles (forming the cerebral hemispheres) develop, the cavity acquires extensions into each of them, and these pockets are the lateral ventricles. The cerebellum has no central cavity of its own. However, it covers over the dorsal aspect of the 4th ventricle, where the roof of this ventricle is paper thin. The walls of the tubular nervous system grow thick in some parts and remain thin in others. The interconnected system develops into (a) larger chamber-like parts called ventricles and (b) small-bored passages referred to as canals, foramina, and in one case, the cerebral aqueduct. All these cavities and passages contain cerebrospinal fluid (CSF) and are lined with ependymal cells.

It is important to understand the three-dimensional structure of the ventricles to be able to recognize cross sections of the brain and their position along the brainstem. As the cranial nerves are ordered from 1-12 along the brainstem, this can also help you work out what nuclei should be present in any given section.

There are also a number of problems which can arise when the circulation of the cerebrospinal fluid (CSF) is blocked or over or under produced. (Note revise CSF production and flow). Blockages can occur in any of the narrowings of the system: between the lateral ventricles and the central third ventricle at the foramen of Munroe (or interventricular foramen) What do you think would be the result of this? Blockage can also occur in the cerebral aqueduct (can you identify this? How thick is it?) What do you think would be the result of this blockage? What might cause such blockages? How could you treat this? More rarely blockages can occur at the three critical points of exit from the 4th ventricle, and can also bring about disease through back pressure.

EXAMINE the medial side of the half brain to make an initial study of these cavities. The central canal of the spinal cord is about 1 mm in diameter and extends into the caudal half of the medulla oblongata. It widens to form the 4th ventricle, which is the most caudal of the brain's ventricles and situated entirely in the hindbrain. Its ventral wall is thick and composed of medulla and pons. The thin membranes, called superior and inferior vela (singular, velum), together with cerebellum form the roof of the 4th ventricle. The CSF is mainly secreted into the ventricles by specialised vascular structures called choroid plexuses (Can you identify this? Where are they? What does it look like?). The fluid must be provided with routes of escape back to the venous system. These take the form of three apertures in the 4th ventricle (foramen of Magendie in the roof, two foramina of Luschka at the two lateral recesses) look for choroid plexus sticking out through the apertures. Having passed through these apertures, the CSF is now in the subarachnoid space and can pass up over the brain to the arachnoid villi that project into the sagittal sinus.

Within the midbrain the cavity reduces to a narrow canal called the cerebral aqueduct. In the diencephalon, the cavity enlarges again to form the cleft-like
respiration and blood pressure, unless the intracranial pressure is relieved rapidly.

In the cerebellum, superior or dorsal and inferior or ventral surfaces can be recognized, a midline unpaired structure, the **vermis**, and symmetrical hemispheres.

**Cerebellar section**

On the medial aspect of the cerebellum, **NOTE** the pattern made by the white matter of the cerebellum, the *arbor vitae*. Also **NOTE** that it is surrounded by a thin layer of cerebellar cortex which covers all the surface of the cerebellum.

There are four nuclei embedded within the white matter of the cerebellum. One of them is deep to the vermis near the midline, and called the **fastigial nucleus**. A little further laterally, the **emboliform** and **globose nuclei** are found. Laterally the **dentate nucleus** can be found.

**You can observe the dentate nucleus grossly in the white matter of the hemisphere. The other nuclei are seen well only in histological preparations.**
6.3 **Cerebellum**

**REVIEW** the attachment of the cerebellum to the brainstem:

The *middle cerebellar peduncle* runs between cerebellum and pons; the *superior* and *inferior cerebellar peduncles* penetrate the dorsal aspect of the brainstem. The superior cerebellar peduncle extends between cerebellum and midbrain while the inferior peduncle extends between cerebellum and medulla.

**NOTE** that the surface of the cerebellum is divided by transversely running fissures. The *horizontal fissure* in the posterior lobe separates superior and inferior surfaces of the cerebellum.

Another functional subdivision of the cerebellum is the *flocculonodular lobe*, which is made up of the midline *nodulus* and symmetrical *flocculi*, and is separated from the rest of the cerebellum by the deep *posterolateral fissure*. The flocculi are united to the nodulus by large white fibre tracts within the posterolateral fissure.

The ventral aspect of the cerebellum rests on the foramen magnum; a shallow circular groove on the cerebellar surface indicates that relationship. The portion of the cerebellar cortex between that groove and the medulla is called the *tonsil*. In pathological conditions with rapidly developing intracranial pressure, the tonsils may be pushed between the medulla and the lips of the foramen. Death can occur by compression of important centres of the medulla controlling...
6.2 Brainstem (dorsal/posterior surface)

Locate at increasingly rostral levels:

(i) the **cuneate tubercles**, adjacent to the trigeminal bulge in the caudal closed medulla;

(ii) the **gracile tubercles**, a bulges on either side of the dorsal midline of the medulla before it opens out into the fourth ventricle.

With which spinal cord structures are the gracile and cuneate tubercles continuous?

(iii) The **inferior cerebellar peduncle**. Is this a feature of the 'closed' or 'open' medulla?

Define what is meant by 'open' and 'closed' medulla.

THE FOLLOWING STRUCTURES CAN BE HARD TO SEE, LOOK AT A NUMBER OF BRAINSTEMS< SOME MAY BE MORE OBVIOUS THAN OTHERS>

(iv) the **hypoglossal trigone**. The base of each triangle lies against the midline on the floor of the most caudal part of the fourth ventricle;

(v) the **vagal trigone**, at the caudal extremity of the fourth ventricle, lateral to the hypoglossal trigone;

(vi) the **sulcus limitans**, dividing each half of the floor of the fourth ventricle into medial and lateral segments;

(vii) the **vestibular trigone** lying laterally, largely on the medial surface of the inferior cerebellar peduncle;

(viii) the **facial colliculus**, lying more rostrally (at the level of the middle cerebellar peduncles) in the paramedian position;

Which nuclear masses underlies these structures?

(ix) Remnants of the superior (anterior) medullary velum;

(x) the **inferior colliculi**, which form the most caudal part of the tectum or roof of the midbrain. They are paired mounds to be seen rostral to the superior medullary velum; They process auditory information and have efferents to cervical muscles.

(xi) the **superior colliculi**, paired hillocks of neural tissue immediately rostral to the inferior colliculi. They process visual information and have efferents to extraocular eye muscles (which cranial nerves?) and to cervical muscles.

What is the name of the ventricular space which is 'roofed in' by the midbrain tectum?
6. LABORATORY 6

Brainstems, cerebellum

BRAINSTEM, CEREBELLUM

6.1 Brainstem and diencephalon (basal/anterior surface)

In the medulla, locate:

(i) the pyramidal tracts, paired ridges on either side of the midline. *(Why are they called pyramids? They are certainly not pyramid shaped!)

(ii) the olives, more rounded bulges of the inferior olivary nucleus, lying lateral to the pyramids. (now these ARE the shape of olive stones or pits) What do they look like in cross section?

At what level of the medulla are the olives found?

Which cranial nerve emerges from the medulla between the pyramidal tracts and olive?

(iii) the bulge of the spinal (descending) tract and nucleus of the trigeminal nerve, lying lateral to the olive, and inferior to the cuneate tubercle. Between which of these structures were the fibres of cranial nerves IX and X and the cranial root of XI located?

What fibres are found in the tract of V?

(iv) The limits of the pons. Which cranial nerves leave posterior to the pons?

In the midbrain region, locate:

(v) the massive cerebral peduncles;

(vi) the interpeduncular fossa lying between them;

In the diencephalic region locate:

(vii) the optic chiasm at the rostral limit of the diencephalon.

How are the cerebral peduncles and optic tracts related on the lateral surface of the brainstem?

(viii) the median eminence of the hypothalamic portion of the diencephalon lies in the area bounded by the cerebral peduncles posterolaterally and optic chiasm and tracts anterolaterally.

What provides the blood supply to this region?

(ix) at the summit of the median eminence will be found the remnant of the pituitary (hypophyseal) stalk.

Where is the rest of the hypophysis?

(x) the mammillary bodies (why the name?)
Removal of the cerebellum.
Dorsal view of brainstem. Following

- Gracile tubercle
- Cuneate tubercle
- Ventral
- Floor of fourth
- Peduncle
- Inferior cerebellar
- Peduncle
- Middle cerebellar
- Cerebellar
tubercle
- IV nerve
- Lateral
thalamus

Cranial nerves:
- Hypoglossal n.
- Spinal accessory n.
- Vagus n.
- Glossopharyngeal n.
- Vestibulocochlear n.
- Facial n.
- Accessory n.
- Trigeminal n.
- Trochlear n.
- Oculomotor n.
- Ophic root
- Ophic chiasm
- Ophic n.
- Ophthalmic n.
- Optic papilla
5.2 Cranial nerves

On the whole brains find the cranial nerves:

I. (Olfactory) Numerous fine nerves are attached to the olfactory bulb, which is part of the brain. The nerves, which have ascended through the cribriform plate of the ethmoid to reach the olfactory bulb, possess many of the characteristics of peripheral nerves (They regenerate for example). Look inside a skull for the holes through the cribriform plate.

II. (Optic) This is an outgrowth of central brain matter (it is not a peripheral nerve) and it extends forward from the optic chiasm. In humans, at the chiasm about 50% of optic nerve fibres cross to enter the opposite optic tract. Which fibres are these?

III. (Oculomotor) This emerges from the midbrain at the interpeduncular fossa, and supplies some of the extrinsic eye muscles. Name the eye muscles not supplied by this nerve.

IV. (Trochlear) This is the only cranial nerve arising from the dorsal aspect of the brain, and it can be found curving around the cerebral peduncle. It is also the smallest cranial nerve. It supplies the lateral oblique muscle which passes through the trochlear ("pulley").

V. (Trigeminal) This large nerve arises from the pons. In addition to its large sensory component, it possesses a small motor part, both of which should be visible. What is the distribution of the three branches of this nerve?

VI. (Abducens) This slender nerve will be found close to the middle at the junction of the pons and the medullary pyramid. What does it supply?

VII. (Facial) This nerve passes out from the brainstem lateral to the abducens at the lateral edge of the junction between pons and medulla. Name the structures supplied by it. Does it have a sensory component?

VIII. (Vestibulocochlear) The two nerves constituting VIII are found at the cerebellopontine angle, immediately lateral to the facial nerve.

IX. (Glossopharyngeal) and
X. (Vagus) These arise as a series of roots just behind the pons, along the side of the brainstem, below the olive. Sometimes the nerves making up IX can be separated from X, but in others it is just a continuous series of rootlets. Note that in an exam the roots will be labelled, you will not have to label them yourselves.

XI. (Accessory) These nerves emerge as a series of fine rootlets, in sequence, along the postolivery sulcus of the medulla immediately lateral to the olive. The posterior roots emerge from the spinal cord and travel rostrally. This nerve is half a spinal nerve and half a cranial nerve. As this is often torn off when the brainstem is removed from the skull it is often difficult to find.

XII. (Hypoglossal) This emerges as a series of rootlets, between the olive and pyramid. Name the major muscles supplied by this nerve.

REVIEW the function and connections of each of the cranial nerves.
5. LABORATORY 5

EXTERNAL FEATURES (BASAL SURFACE), CRANIAL NERVES

5.1 External features of the brain (basal surface)

5.1.1 Brainstem and diencephalon.

On the basal surface of the brain, identify the parts of the brainstem and diencephalon:

(a) The *medulla* lying most posteriorly in continuity with the spinal cord. What could be considered a line of demarcation between spinal cord and medulla?

(b) The *pons*, with its mass of transverse fibres. Note that these fibres continue to the cerebellum on either side as the *middle cerebellar peduncles*.

(c) The *mesencephalon* (midbrain) rostral to the pons, consisting of rostrally diverging masses of fibres which embrace the -

(d) *Diencephalon* most anteriorly, brainstem, note the cranial nerves emerging from its substance.

5.1.2 Cerebral hemispheres: Examine the inferior surface and identify:

(i) the *calcarine fissure* which takes primary visual input

(ii) the *parahippocampal gyrus*, (so named because it overlies the *hippocampus*, a structure involved in memory and emotion) medial to the collateral sulcus in its anterior part. The *hippocampal gyrus* is tucked under the free medial border of the temporal lobe, and is the hidden half of the parahippocampal gyrus. *It is difficult to see at this stage.*

(iii) the *uncus*, the tip of the preceding gyrus, sticking out medially from the parahippocampal gyrus, folded back upon itself medially. Uncus means a "knee" can you see this resemblance? This overlies the *amygdala* (almond shell, named after its shape), a large nucleus in the tip of the temporal lobe. Involved in emotion and memory, this nucleus has a large olfactory input and damage to this area can lead to "uncinate fits" a smell of a very noxious smell often preceding an epileptic fit.
Fig. 1.9 Lateral aspect of the left side of the brain.

Fig. 1.10 Median sagittal section of the brain.
(c) In the temporal lobe, below the lateral sulcus; locate the superior, middle and inferior temporal gyri. The inferior temporal gyrus extends into the basal surface of the brain. At the posterior end of the superior temporal gyrus, two transverse gyri are seen running into the lateral sulcus. These are the transverse temporal gyri (Heschl’s gyri). These gyri are associated with auditory reception. Also within the superior temporal gyrus (posterior part), Wernicke’s receptive speech area is found.

The insula is a cone-shaped portion of the cerebral cortex, which is seen by gently pulling apart the borders (opercula) of the lateral sulcus.

(d) Posterior to an imaginary line drawn vertically from the notch on the base of the cerebrum made by the edge fo the tentorium cerebelli is the occipital lobe, locate the superior and inferior occipital gyri. These constitute the visual association cortex. A prominent sulcus on the medial side of this area is the calcarine fissure, the sight of primary visual cortex.

4.2 Corpus callosum

With great care, separate the cerebral hemispheres by slightly spreading slightly the walls of the longitudinal fissure. Locate the corpus callosum in the floor of the fissure. Identify:

(a) the genu of the corpus callosum anteriorly
(b) the body
(c) the posteriorly situated splenium.

(These are more obvious on the medial side of half brains)

4.3 Cerebellum

Examine the cerebellum and identify the cerebellar hemispheres and the midline vermis. With which lobes of the cerebral hemispheres is the cerebellum in contact? Which brainstem regions are overlapped by the cerebellum? The fourth ventricle is located beneath the cerebellum.

Note the attachment of the cerebellum to the brainstem by the 3 cerebellar peduncles:

(i) middle cerebellar peduncle, which is continuous with the pons;
(ii) inferior cerebellar peduncle, by which the cerebellum is attached to the dorsolateral aspect of the medulla;
(iii) superior cerebellar peduncle, arising from the dorsal surface of the midbrain, under the cover of the occipital lobes. This structure is difficult to see until the cerebellum is detached from the brainstem (Laboratory 6).
4. LABORATORY 4

Whole brains.

INTRODUCTION TO EXTERNAL FEATURES OF THE BRAIN

4.1 Cerebral convolutions - lateral surface

Note the cerebral hemispheres, separated by the prominent longitudinal fissure. Anteriorly are the frontal lobes, posteriorly the occipital lobes, inferiorly the temporal lobes, and superiorly the parietal lobes. Determine the principal features serving as dividing-lines between these lobes.

Identify the central sulcus, lateral (Sylvian) sulcus, and parieto-occipital fissure.

The identification of the central sulcus is often not easy, because the frontal sulci or the central sulcus may be interrupted by a gyrus. The central sulcus runs approximately from the midpoint of the cerebrum at the longitudinal fissure towards the posterior end of the lateral sulcus, which is the largest sulcus on the lateral surface of the brain. The parieto-occipital fissure is mainly present on the medial surface of the brain, although its terminal portion extends onto the lateral surface near the longitudinal fissure.

(a) In the frontal lobe locate:

(i) the precentral gyrus (motor cortex), between the central and precentral sulci

(ii) the superior, middle and inferior frontal gyri and the superior and inferior frontal sulci running sagitally.

The posterior part of the frontal lobe (in front of the precentral gyrus) is called the premotor cortex and functionally is a motor area. Anterior to this the remainder of the frontal lobe (at the pole area) is the prefrontal cortex and functionally is related to diffuse complex characteristics such as motivation, "attitude" and other aspects of personality and decision making. After prefrontal lobotomy, personality changes, compulsiveness of behaviour and a release of inhibitions have been observed.

The inferior frontal gyrus is divided into opercular, triangular and orbital parts. The opercular portion is continuous with the precentral gyrus. Between the opercular and triangular parts the ascending limb of the lateral fissure is found. In the dominant hemisphere, the opercular and triangular parts are the centres for motor control of speech (Broca’s area).

(b) Posterior to the central sulcus is the parietal lobe. In the parietal lobe, locate the postcentral gyrus and sulcus. This is the sensory cortex. The rest of the parietal lobe may be divided by an intraparietal sulcus into superior and inferior parietal lobules. All parietal gyri are sensory cortical centres.
Carefully observe in your specimen the Circle of Willis and the vertebral-basilar system. **DRAW** it as it appears. Pay particular attention to the relative calibre of the arteries and remember that the "ideal" Circle of Willis occurs in only 25% of cases, so that the ideal and normal are not synonymous. Most textbooks show the anterior communicating as about half the size of the anterior cerebral, which itself is less than half the size of the carotid. The posterior communicating is half the size of the posterior cerebral which is half the size of the basilar. **LABEL** your diagram and note any variations from the usual.
sinus. Survival of the brain tissue is dependent upon adequate oxygenation. Occasionally, the main stem of the artery is occluded, and this causes infarction in the major portion of its anatomical distribution.

The anterior communicating artery joins the right and left anterior cerebral arteries. The posterior communicating arteries, one on each side, connect the internal carotid artery with the posterior cerebral artery. COMPARE on your specimen the relative diameters of the posterior communicating and posterior cerebral artery. In your specimen does blood to the posterior cerebral artery come mainly from the basilar artery, or mainly from the internal carotid artery? When the posterior cerebral artery takes its origin primarily from the internal carotid artery, the short connecting branch to the basilar artery becomes the "communicating" artery.

3.3.2 Vertebral - basilar system:
Examine this system on the basal (anterior) aspect of the brainstem. Note the vertebral arteries and the basilar artery. Note also the posterior inferior cerebellar arteries and their relationship to the brainstem and inferior surface of the cerebellum. NOTICE that they do not reach the cerebellum until after they have executed an S-shaped bend to supply the lateral and dorsal medulla. The posterior cerebral arteries are terminal branches of the basilar and can be found passing laterally above the III cranial nerve.

3.3.3 Branches and variations:
NOTE carefully the numerous small penetrating vessels which arise from the proximal ends of the anterior, middle and posterior cerebral arteries. These vessels constitute the main supply to the basal ganglia and diencephalon and are commonly involved in strokes (cerebrovascular accidents or CVA's).
3. LABORATORY 3

ARterial Blood Supply to the Brain

3.2 Arterial blood supply

The brain receives its blood from the two carotid arteries and the vertebral-basilar system. These vessels form an anastomotic system on the base of the brain called the Circle of Willis (described by Thomas Willis, 1664) and the branches of this circle supply arterial blood to the entire brain. IDENTIFY the circle of Willis and TRACE its main branches as described below.

3.3.1 Internal carotid system:

Find the anterior cerebral arteries, which are branches of the internal carotids. They are joined anterior to the optic chiasm by the anterior communicating artery, and supply the medial aspect of each cerebral hemisphere. The middle cerebral arteries, also branches of the carotids, can be seen in the lateral fissure. TRACE the main branches out to the superolateral surface of the hemisphere. 

Think about what might happen as a result of blockage of these arteries, can you see any sign of arterial disease on any of the brains? GENTLY compress an artery between your fingers, is it "crunchy"? Why might this be?

These vessels give rise to a vast network of small vessels which penetrate the brain substance to supply the superficial grey matter, the underlying white matter, and the larger penetrating vessels that nourish deep nuclear areas. These arteries are surrounded by a sleeve of pia. These arterial vessels continue through a capillary bed (the richest is in the grey matter), and then drain toward a deep venous system which ultimately connects with the straight
(e) The ventral (anterior) nerve roots (motor), the component fibres of which emerge as variably sized groups of fibres from the anterolateral aspect of the cord.

(f) The dorsal (posterior) nerve roots (sensory) which enter the cord in another groove, the dorsolateral sulcus

(i) Where are the cell bodies of the dorsal root nerve fibres?
(ii) Where are dorsal root ganglia located with respect to the vertebrae?
(iii) Are there any synapses in the dorsal root ganglia?
the dura from the periosteum of the surrounding bone. An equivalent space is lacking within the skull. Determine the reasons for this difference.

NOTE that the anterior and posterior nerve roots penetrate the dura at the intervertebral foramina. The sleeve of dura surrounding these roots becomes continuous with the epineurium of peripheral nerves.

Identify the arachnoid which extends with the dura down to the level of S2 vertebra. It is separated from the dura by the subdural space, which is more potential than real. The subarachnoid space separating arachnoid from pia however, is wider and contains the CSF. The arachnoid is prolonged for a short distance along the nerve roots.

Identify the pia, which is closely adherent to the surface of the cord. Free folds of pia are found in two places associated with the spinal cord.

Identify these folds:
(a) the filum terminale, connecting the caudal tip of the spinal cord to the blind end of the dural sac.
(b) the denticulate ligaments, (dent, teeth) extending laterally from the whole cord and anchoring it to the dural sac.

On the ventral surface of the spinal cord is the anterior spinal artery, the largest of the arterial channels in the plexus; it is embedded in a condensation of pial tissue.

3.1 External features of the spinal cord

Thirty one pairs of nerve roots arise from the spinal cord producing an appearance of segmentation. For descriptive purposes the cord is divided into 31 segments: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and, in most humans, 1 coccygeal. The bundle of descending nerve roots below the conus medullaris (caudal extent of the spinal cord) is known as the cauda equina.

The spinal cord has a number of longitudinal furrows or grooves. On the ventral (anterior) surface is a deep ventral median fissure. On the dorsal or posterior surface is the shallow dorsal; median sulcus. The dorsolateral sulcus is a fairly distinct furrow which marks the entrance of the filaments of the dorsal roots. The ventrolateral sulcus marks the exit of the ventral root fibres. (Note that ventral becomes anterior in a species that stands vertically like man. In a quadruped like the lab rat, ventral is always ventral.)

EXAMINE the external features of the spinal cord and IDENTIFY the following as well as ANSWER the questions:

(a) The cervical and lumbar enlargements. Why do these develop?

(b) The conus medullaris which is the tapering caudal extremity of the cord. The conus in the adult extends to the level of L1-2 vertebral bodies and one or two vertebrae lower in the infant. In the early embryo, however, the segments of the spinal cord are at the same level as respective vertebrae. How would you explain the disparity between respective cord and vertebral levels which one sees in the adult?

(c) The cauda equina. Explain the formation of this structure.

(d) The filum terminale, which extends caudally from the tip of the conus and terminates on the dorsal surface of the coccyx. Does this structure contain nerve fibres?
confluens of the sinuses

Determine with which parts of the cranial dural folds these sinuses are associated.

Which dural folds separate:

(a) the cerebral hemispheres,
(b) the cerebellar hemispheres,
(c) the cerebellum and occipital lobes?

2.1.2 Arachnoid mater: This is the intermediate meningeal layer. It runs between the dura and the pia consisting of thin spider web like strands of semi-transparent connective tissue which bridges over many of the sulci and gyri on the surface of the brain. It contains the arachnoid villi or arachnoid granulations which can be found along the margin of the longitudinal (interhemispheric) fissure. Look for matching indentations in some of the skulls from older people.

Between the arachnoid and the more deeply situated pia is the subarachnoid space, containing the cerebrospinal fluid (CSF). In the cadavers, the CSF in this space has been considerably reduced by leakage during the removal of the brain. The collapsed arachnoid therefore, looks as if it is lying directly on the surface of the brain. In vivo however, the subarachnoid space may be a few mm deep on the convex surface of the brain.

As the arachnoid bridges over major fissures, the subarachnoid space becomes larger at these sites. These extended subarachnoid spaces constitute the cisterns, which represent variable depths between the arachnoid and pia.

Identify the arachnoid over the brain.

On the dorsal surface of the cerebral hemispheres locate the arachnoid granulations. What is the relationship between these structures and the subarachnoid space? How are the arachnoid granulations related to the superior sagittal sinus? CSF is absorbed into the venous blood from the subarachnoid space via the arachnoid granulations.

Identify two of the major cisterns:

cerebellomedullary cistern (cisterna magna) and interpeduncular cistern (“peduncles:; literally “feet of the brain” from ped – feet as in pedestrian).

2.1.3 Pia mater: This is the innermost of the meningeal layers. It is a thin membrane, which closely follows the gyri and sulci of the brain. It occurs therefore, on the surface of the gyri and in the depth of the sulci, it surrounds th blood vessels as they penetrate the brain.

2.2 Spinal cord

2.2.1 Spinal meninges: These are continuous with the cerebral meninges at the foramen magnum and the spinal subarachnoid and subdural spaces are therefore continuous with the corresponding cranial spaces.

Identify the spinal dura which extends the whole length of the cord and beyond, to the level of S2 vertebra. . Note that in the neural (spinal) canal there is an epidural space. This epidural space, containing veins and fat, separates
2. LABORATORY 2  
Dry skulls, dural skulls, whole brains, spinal cord

MENINGES, DURAL VENOUS SINUSES

Please bring a white coat, with name badge, gloves and basic instruments to this and later labs.

Warning!!!! Creutzfeldt-Jacob disease,

Although we make all attempts to ensure the brains we accept have not come from individuals with this very rare disease we cannot be sure as its symptoms can be very like normal senile dementia. This disease, thought to be carried by prions, is very similar to a human version of BSE (bovine spongiform encephalitis) or “mad cow’s disease”. Prions are very resistant to fixatives and even heat. Please wear gloves.

2.1 Meninges: The CNS structures are enclosed within their bony coverings by three membranes, the meninges. These are the dura mater, arachnoid mater and pia mater.

2.1.1 Dura mater: This is the outermost meningeal layer and is tough, white and fibrous.

Identify on a skull the points of attachment of the falx cerebri, tentorium cerebelli and falx cerebelli. What is the relationship of these structures to the dura mater?

Identify the positions of the intracranial venous sinuses on a dry skull and on a skull containing the dural folds (reflections).

Identify the following sinuses:

superior sagittal sinus
inferior sagittal sinus
transverse sinus

straight sinus
sigmoid sinus
superior petrosal sinus
inferior petrosal sinus
cavernous sinus
particularly in animals, as the “tectum” or “roof” over this aqueduct) to open in to
the fourth ventricle under the cerebellum. CSF escapes from here via the lateral
foramina of Magendie and the centrally, posteriorly placed foramen of Luschka
to travel over the cortical surface to be resorbed by the arachnoid villi on the
dorsal surface of the cerebrum.

1.6 Cerebellum: This is located posterior to the pons and medulla, and inferior to
the occipital lobes of the cerebral hemispheres. It is divided into two bilateral
hemispheres, with a narrow connecting band, the vermis, joining the
hemispheres across the midbrain. Like the cerebral hemispheres, the surface
of the cerebellum has numerous sulci and fissures (folia), while it is divided into
an outer grey cortex surrounding an inner core of white matter. Also like the
cerebral hemispheres, it has a number of deeply situated central grey masses,
the cerebellar nuclei. It is largely concerned with the control of motion.

1.7 Meninges: The meninges are subdivided into the dura mater, arachnoid and
pia mater. Each is a separate sheet of connective tissue, ranging from the
tough inelastic dura to the pia, which is little more than a thin vascular layer for
the transmission of blood vessels to the brain. The pia follows closely the sulcal
indentations on the surface of the brain. The arachnoid, a spider web like layer
of fibrils, by contrast, is avascular; it does not generally follow the sulci but fills
the subarachnoid space, between pia and dura, through which flows the
cerebrospinal fluid and in which are found large blood vessels.

1.8 Spinal cord: The spinal cord extends from its junction with the medulla at the
level of the foramen magnum, to the upper border of L2 where the cord
terminates as the conus medullaris. The filamentous filum terminale runs
between the conus and its attachment to the coccyx. Its meningeal coverings
are the same as, and continuous with, those of the brain.

The cord has cervical and lumbar enlargements which are associated with
sensorimotor interconnections to the arms and legs respectively. As the cord is
shorter than the vertebral canal, the lower nerves have courses within the canal
which are far more oblique than those of the upper ones. Consequently, the
lower lumbar, sacral and coccygeal nerves run inferior to the termination of the
spinal cord, running alongside the filum terminale. These nerves plus the filum
constitute the cauda equina. It is in this area, below the spinal cord proper, that
lumbar punctures and epidural anaesthesia are administered.

The cord itself has a ventral (anterior) median fissure and a less noticeable
dorsal (posterior) median sulcus. Laterally the ventral (motor) and dorsal
(sensory) rootlets of the spinal nerves emerge from ventrolateral and
dorsolateral sulci respectively.
There are however, important cortical areas we need to associate with major functions. The precentral gyrus is motor in function, and the postcentral gyrus sensory; these are the motor and somesthetic receptive areas. Within the lateral sulcus in the upper part of the temporal lobe is the anterior transverse temporal gyrus (Heschl's gyrus). This is the auditory receptive area. The gyri on either side of the calcane sulcus form the primary visual receptive area.

Looking at the median surface of the cerebral hemispheres, it can be seen that the hemispheres are joined together across the midline by a very large bundle of nerve fibres, the corpus callosum. Inferior to (below) the corpus callosum are parts of the diencephalon, namely the thalamus and below it the hypothalamus. The corpus callosum is missing in marsupials and primitive mammals such as the hedgehog and duck billed platypus.

1.3.2 Basal ganglia: These lie deep within the cerebral hemispheres

These structures are only visible in horizontal sections through the cerebrum or after dissection of the cerebrum. They are important in motor control.

1.3.3 Diencephalon: The diencephalon, in the form of the thalamus and hypothalamus, is continuous with the midbrain. It consists of a number of subdivisions, the main ones being:

- thalamus (dorsal thalamus)
- hypothalamus
- epithalamus (including pineal body)
- subthalamic nuclei

The thalamic region as a whole forms the walls of the 3rd ventricle, the main bulk of the thalamus lies inferior to a part of the choroid plexus and to the fornix (which is an arched commissure linking up the hippocampus with parts of the diencephalon). Ventral to the thalamus is the hypothalamus. The mammillary bodies, which are found associated with the hypothalamus, are ventral to the thalamus.

1.4 Brain stem: This consists of three main regions - the midbrain, pons and medulla.

The dorsal surface of the brain stem is characterized by a large number of features, only a few of which we need consider in this introductory section. On the midbrain are the colliculi (small “colls” or hills), the superior and inferior, as well as the origin of the IV cranial nerve. Inferior/posterior to these are the cerebellar peduncles, (literally “feet” of the cerebellum), the superior, middle and inferior, which connect the cerebellum to the midbrain, pons and medulla respectively. In the roof of the medulla is the fourth ventricle.

1.5 Ventricular system: The large cavities within the substance of the cerebral hemispheres and brain stem are the ventricles, which together form the ventricular system and serve as a channel for the cerebrospinal fluid. There are large “C” shaped cavities in the cerebral hemispheres (ventricles 1 and 2) with choroid plexus in their roofs producing CSF. They are joined to a thin third ventricle between the thalami, about the size and shape of a twenty cent piece, by the narrow foramina of Monro. The narrow and easily blocked cerebral aqueduct then leads back under the colliculi (this area is also known,
NOTE: New neuroanatomical terms you should learn are indicated in **underlined italics**.

1.3 Cerebrum: In terms of this classification the **cerebrum** consists of the two cerebral hemispheres (the wrinkled “outside” of the brain), the **basal ganglia** inside them (important in motor control) plus, on top of the brainstem, the main intermediate nuclei important for communication between the cerebrum and brainstem (leading then to the spinal cord and body), the **thalami** (singular, **thalamus**).

1.3.1 Cerebral hemispheres:

The cerebral lobes are made up of an outer layer of **grey matter** (actually pale beige in the fixed brain – predominantly composed of cell bodies) folded in to prominent creases known as **gyri** (singular, **gyrus**). The **cerebral cortex** and an inner area of **white matter** (containing many **myelinated** nerve fibres).

Each cerebral hemisphere is divided into a number of geographical areas called “**lobes**”, the names of which correspond to the bones of the skull overlying them rather than any particular function. They are however useful when describing the position of various structures, functions or lesions on the cerebrum, (rather like the terms abdomen or pelvis on the body). The lobes are separated from each other by deep fissures or **sulci**. There are two prominent sulci on the **lateral** surface of the cerebral hemispheres. These are the **lateral (Sylvian) sulcus** and the **central sulcus (of Rolando)**. The central lobe buried deep to the lateral sulcus, only visible when the temporal lobe is pulled down, is called the insula. Inferior to the lateral sulcus is the **temporal lobe**, in front of the central sulcus is the **frontal lobe**, just posterior to the central sulcus is the **parietal lobe** and posteriorly is the **occipital lobe**. The boundary of the occipital lobe is marked artificially by an imaginary line drawn vertically from the notch created on the lower surface of the cerebrum by the **tentorium cerebelli**, the lower fold of **dura** separating the cerebrum from the **cerebellum** in the skull.

Turning now to the medial surface of the cerebrum we can again recognize the central sulcus, which partially divides the **paracentral gyrus**. This continues onto the dorsolateral surface as the **pre- and postcentral gyri**. These gyri are important as they are the primary areas for processing motor (pre) and sensory (post) information from the body. The occipital lobe has a narrow sulcus running through its medial surface, the **calcarine sulcus**, important because the primary visual processing occurs here within the occipital lobe. The **cingulate sulcus** runs parallel to and above the corpus callosum, the **cingulate gyrus** lying between it and the corpus callosum.

The cingulate gyrus, and the more posteriorly-situated parts of the cerebral hemispheres on the medial and posterior surface such as the parahippocampal gyrus (so called because it lies above the **hippocampus**, a structure involved in memory and many other basic functions) the hippocampus itself and the uncus represent the phylogenetically older parts of the brain, that is, the **archicortex and paleocortex**, as opposed to the remainder of the cerebral hemispheres which constitute the **neocortex**.

Over the years a great deal of attention has been devoted to the precise localization of specific functions within the cerebral hemispheres. Some of this emphasis has led to extremes, so much so that the hemispheres have been treated as though they consist of numerous discrete functional units, each existing independent of the others. This is quite erroneous, and we will return to this problem when we deal with the cerebral hemispheres in detail in the lectures.
Laboratory 1

INTRODUCTION

(Demonstration ONLY, no demonstrators) A video of the presentation is available in the Biological Sciences Library.

1.1 The brain as a whole object:
1.1.1 Although in its fixed state the brain is firm and possesses a definite shape, in life it is soft "like two fistfuls of pink-grey tissue, wrinkled like a walnut and something of the consistency of porridge".

What this means in practical terms is that in an operation the surgeon removes brain tissue with an aspirator rather than a scalpel, and controls bleeding using cautery (a hot wire to burn or fuse soft tissue) rather than a suture. Up to 25% of its substance in the adult is extracellular space. The thick complex of membranes around the brain (the meninges) are essential to suspend and protect the almost semi-liquid brain inside the skull. Remember that a large proportion of the brain is myelin, myelin is a mixture of lipids (fats) and proteins. Think of the consistency of butter at 37°C!

1.2 Subdivisions of the CNS: The major physical subdivisions are as follows:

Brain:
- Cerebrum, Brainstem, Cerebellum

Spinal cord

Subdivisions of the peripheral nervous system:
- “Somatic” peripheral nervous system
  - Motor and Sensory (includes visceral sensory)
- Visceral motor system
  - Sympathetic, Parasympathetic
  - True visceral nervous system (not always described in text books)

These structures can be identified grossly on the intact brain and can be thought of as divisions like “thorax” or “abdomen” in the body.

While it is convenient to divide up the brain in this manner, it would be unwise to assume that the cerebral hemispheres can be neatly separated from the brain stem. It is salutary to bear in mind the fact that while some people consider the thalamus (two large groups of nuclei lying between the brainstem and the cerebral cortex) belongs to the brain stem, others place it in the cerebrum. Developmentally it is closely associated with the cerebrum, while fibre tracts passing in both directions between it and the cerebral hemispheres mean that, functionally, it is intimately related to them. Then again the cerebellum has connections with the thalamus, midbrain, pons and medulla.

The problem is, as in so much of anatomy, the naming of parts has occurred over many centuries and has followed many conventions. The naming is sometimes “geographical”, relating to place. (“head”, “spinal cord”), while in others it is related to function (“rotator cuff muscles of the shoulder joint”, “the sympathetic nervous system”) in other cases it is related to development (“endodermal and mesodermal tissues”, “prosencephalon” or “forebrain”), to further confuse matters some structures are named by the structures they connect (the “sternocleidoid muscle” – “the muscle that runs from the sternum and clavicle”, the spino-cerebellar tract) or by pure poetic, latin or greek whim (the “ansa cervicalis” – a bundle of nerves taking a sweeping path resembling a swans neck! Or “hippocampus” – a nucleus resembling a sea horse rising out of the waves!).
“How much detail do I need to know”

This is a question that plagues students at all levels. Different courses/units have different requirements. In this unit concepts and understanding matter more than detail. Descriptive detail will be kept to a minimum. A few facts, however, have to be learnt. The approach here is to begin with the bare minimum facts and logically build a picture on them. It enhances learning with no ‘information overload’. You will soon realise that long paragraphs can be reduced to ideas that can be expressed in a few simple phrases. Sometimes descriptions are explanatory - do not attempt to memorise them! When they are understood, they fade into the background, to be replaced by simpler statements. In this context you will find a lot of help in the lectures, labs and on the website.

“Do I need to learn to draw”? 
There are a few drawing exercises in the manual and very often an answer with an illustration makes an impact. You do not have to be an artist to draw simple illustrations. All you need to do is to draw simple, line diagrams. Revision/self-assessment questions on the website will easily give you an idea of how simple this is!

Using this manual

This manual is not a substitute for a textbook. It serves as a guide to lab study with some (hopefully!) stimulating questions. These questions are not necessarily "examination type" questions. Filling in all the answers is not equivalent to exam preparation.

The website for 910.217

http://www.lab.anhb.uwa.edu.au/hb217
Besides lectures, labs and textbooks, the website is the most comprehensive resource for this unit. It is designed to specifically cater to the breadth and depth of this unit. It gives a detailed plan of the unit with lecture summaries, lectures in PowerPoint format, a web version of the Lab manual, study guidelines and a large amount of revision/self-assessment material.

The website is simple to navigate. It is rich in graphic material that is easy to download. It is an open site requiring no registration or passwords (except the procedure for logging in if you are using a computer on the campus). It is accessible from computers within or outside the campus. If you are accessing it from outside the campus you will need internet access and a browser capable of supporting frames and graphics - most browsers have this capability these days.
Guidelines for Study
(And answers to FAQs!)

Attendance

The importance of regular attendance cannot be overstressed. True, there are books, there is this manual and you have the website. If these were adequate, this unit (or any other unit for that matter!) would not have been run the way it is. The focus of the unit can best be brought out only through the classes. It is your responsibility to see how you can get the best out of this unit.

Prerequisites

Studying this unit will be very easy if you refresh the knowledge from the prerequisite units. If you have manuals from the earlier units (especially HB 100), do read through the relevant portions. You will see bridges between what you know and what you will learn at every stage.

Lectures: What and How

Lectures are not mere reproduction of factual material which can be seen in lab sessions. They are theme-based. Awareness of what you have learned in the prerequisite units will go a long way. PowerPoint presentations of lectures are not masses of text! They highlight essential concepts and keywords and give graphic basis.

Laboratories

The lab gives you the best opportunity to see ‘things as they really are’. Lab specimens, like pictures and models are not to be stared at to memorise what is where. They should be read like books. Spend a few seconds for orientation. Instead of just ‘identifying’ a structure, think where it comes from, where it goes and why it is what you think it is. Merely memorising the identity is a burden; knowing what it is, a pleasure. Human structure, like all things biological, varies within normal limits. Do not stick to one table or one specimen; take the opportunity to see all you can. All the features may not be seen in a -single specimen. Handle (gently!) the specimens yourself. Looking at them from a distance is going back 500 years to the pre-Vesalian era.

Looking back, looking forward.

Neuroanatomy requires a bit of back-and-forth study. Your knowledge of, say the spinal cord will be recalled again when you study the sensory or motor systems. Bear this in mind and look back and forwards in your lab sessions also.

Go step by step.

Once again I do not mind repeating : this laboratory programme is designed to give the essentials at every stage. Focus on them during each lab. You will thus find various features of the midbrain mentioned at three different points in time - depending on what is relevant at each point. However, if you wish, and can absorb, you may pace yourself faster!
Laboratory regulations are also posted in the laboratory. Take time to read them carefully.

These must be adhered to.

1. A lab coat is a must. It is meant to protect you from contact with lab material. For this reason it must have functional buttons! For an occasional emergency or eventuality, a lab coat may be hired from the lab. Remember that lab coats for hire are in limited supply.
2. Footwear that covers the foot is a must for the same reason.
3. The use of hand gloves is mandatory when handling wet specimens.

4. Wear a name tag - even if it a simple one that states your given name and surname! Remember that student lists are compiled alphabetically by surname. Also bear in mind that it is difficult to commit over 150 names and faces to memory.

Non-compliance with the above regulations will result in denial of entry to the lab.

5. Handle all material with due care and respect.

Preparation of material used in study is difficult and time-consuming. Careless handling damages it and effectively denies study opportunity to you and those who use it after you.

Human material comes from real life individuals, most of whom have voluntarily bequeathed their mortal remains to us for study. It is absolutely imperative, without reservations and exception, that we treat it with dignity and respect.

6. No laboratory material may be moved out of the laboratory - failure to comply with this has serious consequences.

Warning!!!! Creutzfeldt-Jacob disease.

Although we make all attempts to ensure the brains we accept have not come from individuals with this very rare disease we cannot be sure as its symptoms can be very like normal senile dementia. This disease, thought to be carried by prions, is very similar to a human version of BSE (bovine spongiform encephalitis) or "mad cow's disease". Prions are very resistant to fixatives and even heat. Please wear gloves.

The Internet

Websites relating to the study of anatomy are a legion. Many of the sites are specifically designed for courses offered by schools or universities. The approach and the detail may not be suitable for this unit. One needs to exercise some caution in the use of these. Some of them may be popular science sites Details of the website for this unit are in the next section.
About This Unit

Another myth is that the brain is a strange, unreal object. The reality is that the brain is different in its structure and organisation compared to the rest of the body. On one hand it is fairly homogeneous in its composition. It is made of neurons and their supporting tissue. A neuron, like other cells, has a body - mass of cytoplasm containing the nucleus. It also has, unlike other cells, 'processes' (nerve fibres) that conduct electrical impulses. Many of these are covered by an 'insulating' layer, myelin, which is fatty and white in colour. Neuron bodies when aggregated together appear grey, masses of nerve fibres appear white. The brain (and the spinal cord) is therefore has only two colours, grey and white. In other parts of the body we have a range of colours evidenced by muscles, tendons, bones, internal organs and so on. Other parts of the also exhibit a variety of textures and consistencies. The brain in the fresh state is a porridge-like mass, in the fixed state in cadaveric material it is like soft, crumbly cheese.

Lectures
As stated in the timetable, the lectures will be conducted by Professors Stuart Bunt and Alan Harvey and Dr. Avinash Bharadwaj. The venues and the timings are set out in the timetable. It is expected that you attend all lectures. Lectures are not mere reproduction of factual material which can be seen in lab sessions. Lectures are theme based, help by way of explanations and also give guidelines as to the depth of study expected. Remember, textbooks have a wide coverage and vary in level of detail.

Laboratory classes
The contents of each laboratory are specially designed for easy assimilation. At no stage will you come across exercises that are not immediately relevant. The first week gives you an overall scheme of the nervous system with elementary functional correlation. The next two weeks introduce to some areas of overall interest. Weeks 4 to 7 are for basic external and internal features of the brain and the spinal cord. Weeks 8 to 11 integrate this knowledge in the understanding of the larger picture of the functional ‘systems’ in the brain and the spinal cord. In the last two weeks you will be able to revise the entire content in the presence of demonstrators.

You will thus see that the programme gives you ample opportunity to stop, revise, integrate and go ahead. It is vital that you utilise the opportunity to the fullest extent.

The laboratory classes are arranged every Friday 2 to 4 p.m.in two sessions in the dissecting Room (DR), Ground floor, Anatomy and Human Biology Building. If you have difficulty in attending the session contact the coordinator smbunt@anhb.uwa.edu.au. 6488 2983).
NEUROANATOMY LABS

1. PRELIMINARY READING

There are two big difficulties facing students studying the brain for the first time.
A) A largely foreign terminology
B) An organ whose subdivisions and connections are often invisible without special techniques to reveal them.

We are all familiar with terms like “pelvis”, “lung”, and “thorax” without any special study. We can also visualise and identify these structures as 3D objects. On the other hand, in the brain, terms such as “hippocampus”, “thalamus” or “mesencephalon” conjure up no such real images.

In week 1 I will provide a brief overview of the brain and its major component parts. In week 2 and 3 you will be looking at superficial structures on the brain such as the blood vessels and meninges. This will provide a gentle transition from the more familiar structures such as veins and arteries to the more specialised tracts (bundles of fibres) and nuclei (groups of nerve cells) of the CNS.

A brief introduction is provided for you here. You should read this and back it up by reading the introductory chapter of a good anatomy or neuroanatomical text before the first “real” practical in week 2.

You should organise your studies so that by week 4 you should be familiar with the major subdivisions of the CNS and the names of the main areas and structures that make up the CNS. A small self-assessment exercise will be provided in week 4 to test your knowledge.
BOOK LIST

There are more neuroanatomy texts than almost any other subject, it seems that everyone who runs a neuro course wants to write a textbook. They nearly all contain too much detail for this course. These are interesting texts that you will find in the library, they are not required reading but nearly all of them will help your studies. If you have the choice between a second hand book and none, get one of these. The recommended texts which should be in the book shop are marked with #. My other “favourites” are starred*. I have asked the bookshop to order in some copies of each book that is still in print. Unfortunately many never appear on the shelves as they are reluctant to hold much stock. Ask at the order counter so they can say (as you demand it) “there’s no demand for that book”.

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<th>TITLE</th>
<th>AUTHOR</th>
<th>PUBLISHER</th>
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<td>#The Human Brain - an introduction to its functional Anatomy</td>
<td>Nolte J</td>
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<td>#Neuroanatomy, An illustrated colour text</td>
<td>Crossman, A.R.and Neary D.</td>
<td>Churchill Livingston</td>
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<td>Good for labs:</td>
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<td>*Neuroanatomy – An atlas of Structures, Sections &amp; Systems</td>
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<td>The Human Brain in Dissection</td>
<td>Montemurro D, Bruni J</td>
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<td>The Peripheral Nervous System</td>
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<td>Preparation for 3rd Year neuroscience</td>
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<td>Zigmond M, Bloom F,</td>
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<td>Neuroscience – an illustrated guide</td>
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<td>From Neuron to Brain</td>
<td>Kuffler S, Nicholls J,</td>
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<td>Neurobiology</td>
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<td>FitzGerald M</td>
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<td>*Basic Clinical Neuroanatomy</td>
<td>Young PA, Young PH</td>
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<td>Sarnat H, Netsky M</td>
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<td>Elements of Molecular Neurobiology</td>
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<td>John Wiley &amp; Sons</td>
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<td>Development of nerve cells and their connections</td>
<td>Hopkins WG, Brown MC</td>
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<td>Study Guides etc.</td>
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<td>Snell RS</td>
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<td>A study Guide to accompany The Human Brain</td>
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<td>Neurological Differential Diagnosis</td>
<td>Patten J</td>
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<td>Wilkinson JL</td>
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### Lecture and Laboratory Timetable: Semester 2 - 2004

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<tr>
<td>Week 1</td>
<td>19 July</td>
<td>11 am</td>
<td>Introduction to Human Neurobiology</td>
<td>SMB Intro. and Overview</td>
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<td>21 July</td>
<td>9 am</td>
<td>Development of the CNS I</td>
<td>SMB</td>
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<td>Week 2</td>
<td>26 July</td>
<td>11 am</td>
<td>Neurons &amp; glia</td>
<td>AVB Meninges, ventricles</td>
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<td>28 July</td>
<td>9 am</td>
<td>Meninges, ventricles (Short L)</td>
<td>SMB</td>
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<tr>
<td>Week 3</td>
<td>2 Aug</td>
<td>11 am</td>
<td>Blood supply</td>
<td>SMB Blood supply</td>
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<td>4 Aug</td>
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<td>Spinal cord</td>
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<td>Week 4</td>
<td>9 August</td>
<td>11 am</td>
<td>Thalamus &amp; cerebral cortex I</td>
<td>ARH External Features of the brain and spinal cord</td>
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<td>11 August</td>
<td>9 am</td>
<td>Cerebral cortex II</td>
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<td>Week 5</td>
<td>16 August</td>
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<td>Brain Stem and Cranial Nerves I</td>
<td>SMB External Features (Basal Surface) Cranial nerves</td>
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<td>Visual system I</td>
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<td>Week 6</td>
<td>23 August</td>
<td>11 am</td>
<td>Brain Stem and Cranial Nerves II</td>
<td>SMB Brainstem, Cerebellum</td>
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<td>Hupothalamus and Limbic System</td>
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<td>Motor system I</td>
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<td>AVB Horizontal and Coronal Slices</td>
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<td>Week 9</td>
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<td>Auditory and Vestibular Systems</td>
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<td>AVB</td>
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</tbody>
</table>

**TWO WEEKS STUDY BREAK**

<table>
<thead>
<tr>
<th>Week 10</th>
<th>4 October</th>
<th>11 am</th>
<th>Development of the CNS-II</th>
<th>SMB Tissue Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 October</td>
<td>9 am</td>
<td>Postnatal plasticity</td>
<td>ARH</td>
</tr>
<tr>
<td>Week 11</td>
<td>11 October</td>
<td>11 am</td>
<td>Evolution &amp; the brain</td>
<td>SMB Tissue Sections (brainstem)</td>
</tr>
<tr>
<td></td>
<td>13 October</td>
<td>9 am</td>
<td>Aging &amp; trauma</td>
<td>ARH</td>
</tr>
<tr>
<td>Week 12</td>
<td>18 October</td>
<td>2 pm</td>
<td>Repair of adult brain and spinal cord</td>
<td>ARH Somatosensory System Revision</td>
</tr>
<tr>
<td></td>
<td>20 October</td>
<td>11 am</td>
<td>Memory</td>
<td>ARH</td>
</tr>
<tr>
<td>Week 13</td>
<td>25 October</td>
<td>2 pm</td>
<td>Neuroimaging &amp; higher functions</td>
<td>SMB Revision and practice lab questions</td>
</tr>
<tr>
<td></td>
<td>27 October</td>
<td>11 am</td>
<td>Revision session (207 + 210)</td>
<td>SMB + ARH</td>
</tr>
</tbody>
</table>

SMB Professor Stuart Bunt  e-mail smbunt@anhb.uwa.edu.au
ARH Professor Alan Harvey.
RH Dr Rob Hart (Guest lecturer)
AVB Dr Avinash Bharadwaj
As a student

I ask you to:

1. **Try to learn as much as possible, you can help this if you:**
   - Attend lectures
   - Come on time
   - Pay attention (or sleep quietly…..remember, do not snore)
   - Keep organised, look out for notices, check timetable details
   - Get a text book….and read it before each lab (or at least bring it along)

2. **Please give me more time to teach by**
   - Not asking obvious questions when the answer could be found in a book
   - Making appointments, or better still e-mail me
   - Not talking in lectures

3. **In labs**
   - Wear a white coat (your non-biological friends will appreciate it)
   - Bring basic instruments (probe, scissors, forceps)
   - Wear a name tag (I will never learn 60 names in 13 weeks)
   - Listen to instructions
   - Look after the material (it could be your grannies brains we are poking, we are very dependent on donors for material, if we catch you damaging the specimens you could well be the next donor…..)
207 and 210 ground Rules

A learning contract

As a course co-ordinator:

1. I will try to keep the course:
   - Organised (probably physiologically impossible…I am an academic after all! But I will try my best)
   - Interesting (this depends a little on you, if you close off your mind, it will get tedious)
   - Challenging (Some philosophers would say trying to understand your own brain, using a brain, is impossible…you may agree by the end of this course….)
   - Understandable (stop me when you do not understand)
   - Fun

2. As a teacher
   - I will try to answer all sensible questions when possible
   - I will respond to questions in lectures with good humour (I reserve the right to be human and grumpy on wet winter mornings)
   - I will answer e-mails within two working days
   - I will endeavour to arrange an appointment to see any students who need more help (but note, I teach more than 250 students this semester, even if I saw you for only 10 mins a week each, that would be more than 40 hours a week without any time for teaching, research, preparation etc.)
   - I will respond, where possible and sensible, to requests to alter the course (no, I will not remove the exam…)
   - I will endeavour not to be sexist, racist or otherwise discriminatory (daren't make a joke about this ….have you heard the one about the .. and the ….oh no better leave that!)

3. I will not
   - Act as a mobile textbook for those unwilling to read a book or visit the library (sorry, but yes, I will snap your head off if you ask stupid questions...see third point). Remember, I want to challenge you to think, not spoon feed you. You are second years now, not highschool students.
   - Guarantee to be available when you turn up unannounced at my office (I run three labs, am director of an art studio and imaging facility in the Anatomy and Human Biology Department, I do not have a desk job, I do however have an answering machine and read my e-mail regularly)
   - Tolerate fools gladly
   - Tolerate talking in lectures (repeated offenders will be thrown out, if you are bigger than me I will leave, then your fellow students will beat you up….your choice)
   - Answer questions after a lecture when the next lecturer is waiting to start or I have another lecture
   - Give the questions that will come up in the exam (I want you to learn, although I hope you too are here to learn you also need to pass exams. This leads to conflict. To make you learn the most, I should not tell you anything about the exam, you would panic and learn as much as you can. From your point of view I should give you the questions before the exam. Then that is all you would have to learn! Hopefully we can come to some kind of compromise)
One day she brought in something special:
"This is the human brain."
It was the color of wet clay,
webbed with tattered membranes.
It trembled on the metal tray.
This, then, was the miracle
of thought. Mother prodded it
with a glass rod.

Cats', rabbits', and goats' brains
were the brains of the day.
Hypothalamus was a household word.
I hardly noticed, but a friend
almost fainted once
when Mother passed through the room
in a white coat,
carrying a brain-cutting saw
like an avenging angel.

I liked the Gothic
armature of labs,
the dark hush,
the red warning lamps;
anatomy sketches
scribbled over in Latin,
names of clouds and stars,
of genus and species.
I sat on the windowsill,
four flights above sad Warsaw,
blessing flat Socialist rooftops:
Paramecium caudatum.

Oscillographs clicked,
spinning green sinusoids.
Sagittal cross-sections
cluttered up our groceries
behind the steel claws of cold storage.
I leafed through foreign
neurology journals,
a word-eating larva, waiting
to become a butterfly, methyl blue,
pinned in the heaven of science.

Ivy Warwick was born in Poland and moved to the United States at the age of 17. Her poetry has won several awards and has been widely published in literary magazines, including Poetry; Best American Poetry 1992; Ploughshares; The Iowa Review; The Prairie Schooner, Texas Review, and Southern Poetry Review - she has also had her translations of Polish poetry published. She has published a book, Hormones Without Fear (College Pharmacy, 1997), and for two years was the publisher of an e-newsletter, CyberHealth. She is currently a staff writer for the Life Extension Foundation and teaches creative writing and literature at Miracosta College in Oceanside, California. She still writes an occasional poem.