Discipline of Biomedical Science
School of Medical Sciences
Sydney Medical School
The University of Sydney

Unit of study outline

BIOS1171
Neuroscience
Semester 1, 2017

Unit of study overview

This unit of study aims to introduce you to the human nervous system in both health and disease. There is an emphasis on the reflex loop as the fundamental circuit of the nervous system. The unit comprises the following seven topics.

1. Basic structure: the basic anatomy of the nervous system including spinal cord, brainstem and cranial nerves, and forebrain
2. Basic function: the fundamentals of nervous system function including axonal transmission, synapses, and the neuromuscular junction
3. Sensory processes: an introduction to somatosensation, pain, vision, hearing, and the vestibular system
4. Spinal reflexes: motor responses supported by neurons in the spinal cord
5. Motor systems: principles of motor control including upper and lower motor neurons, postural control, and systems contributing to movement
6. Blood supply: the vascular system supplying the nervous system
7. Autonomic nervous system: an introduction to autonomic structure and reflexes.

The case studies aimed at identifying simple neural problems associated with sensory and motor systems are specifically designed for students following professional preparation degrees. Material will be presented in lectures, tutorial and practical sessions.

Textbooks

It is best to use the latest edition of a textbook, although an earlier edition should still be useful. The anatomy textbook for this unit is:

- Crossman, A. R. & Neary, D. (2014). *Neuroanatomy: An illustrated colour text*. Churchill Livingstone.

For physiology, you have a choice:

- Martini, F. H. Nath, J. L. & Bartholomew E. F. (2015). *Fundamentals of Anatomy and Physiology*, 10th Global edition, Pearson Benjamin Cummings, Boston.
- Purves, D., Augustine, G. J., Fitzpatrick, D., Hall, W. C., LaMantia, A.-S. & White, L. E. (2012). *Neuroscience*. Sinauer Associates.

Martini *et al*. is broad-spectrum and will not cover all you need to know in physiology. Purves *et al*. (2012) is more encyclopedic and will be valuable if you propose to take your study of neuroscience beyond this unit of study.

References

The textbooks will probably not answer all of your questions. You are therefore advised to make good use of the Library, and to supplement your lectures and textbook whenever necessary with information from additional sources. On occasions, your lecturers may recommend other sources of information for particular aspects of your work.

There follows a list of books that you may find useful for reference purposes.

Health sciences

- Barrett, K. E., Boitano, S., Barman, S. M. & Brooks, H. L. (2012). *Ganong's review of medical physiology.* Lange Medical Books/McGraw-Hill.
- Palastanga, N. & Soames, R. (2012). *Anatomy and human movement: structure and function*. Churchill Livingstone.
- Tortora, G. J. & Derrickson, B. H. (2014). *Principles of anatomy and physiology*. John Wiley & Sons.

Neuroscience

- Baehr, M. & Frotscher, M. (2012). *Duus' Topical diagnosis in neurology*. Thieme.
- Bear, M. F., Connors, B. W. & Paradiso, M. A. (2006). *Neuroscience: exploring the brain*. Lippincott Williams & Wilkins.
- Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S. A. & Hudspeth, A. J. (2013). *Principles of neural science*. McGraw-Hill.
- Kiernan, J. A. & Rajakumar, N. (2013). *Barr's The human nervous system: an anatomical viewpoint*. Lippincott, Williams, and Wilkins.
- Nolte, J. (2008). *The human brain: an introduction to its functional anatomy*. Mosby/Elsevier.

Unit of study coordinator

All general questions concerning the unit as a whole should be addressed to the unit of study coordinator. Such questions include matters regarding advanced standing, medical certificates and examinations.

Dr Jin Huang: Room L223, (02) 9351 9065, Jin.Huang@sydney.edu.au

Lecturers

Difficulties related to the content of the unit should be referred to the appropriate lecturer, tutor or demonstrator. All teaching staff members within this unit of study would appreciate your cooperation in making appointments at mutually agreeable times, should you wish to discuss any aspect of the work with them.

Dr Alan Freeman: Room L230, (02) 9351 9321, Alan.Freeman@sydney.edu.au
Dr Damian Holsinger: Room L226, (02) 9351 9324, Damian.Holsinger@sydney.edu.au
Dr Jin Huang: Room L223, (02) 9351 9065, Jin.Huang@sydney.edu.au
Dr David Mor: Room L231, (02) 9351 9322, David.Mor@sydney.edu.au

Lectures

There are three lectures per week.

From time to time unforeseen circumstances may necessitate the cancellation of lectures. If this occurs, the Discipline of Biomedical Science will endeavour to schedule a replacement lecture at the earliest convenient time. However, timetabling constraints may make rescheduling impossible. In these circumstances an alternative that is deemed educationally valid will be provided. Under no circumstances will students be educationally disadvantaged by lecture cancellations.

Practical and tutorial classes

Each week, these classes are two hours long. It is important to note that most of the unit of study's content is introduced in lectures but some is introduced in tutorials and practical classes. Content presented in practical and tutorial classes will be examined in the mid-semester and end-semester exams. It is therefore important to prepare before each class. Remember to bring your lecture notes to the class.

You have been allocated to a group. Check the time of your practical or tutorial on your personal timetable. You must attend your own practical/tutorial at the time and place indicated. You may not swap groups for your own convenience. Each tutor will have a class list and regular attendance checks will be made.

The classrooms are located above the Anatomy Lab. The assignment of groups to rooms, as well as a map of these rooms, can be found on the notice boards next to Room L217 and other labs. The room for your group may change from week to week, so check the assignments on the day. Also, the exact location of the class can be confirmed through the online timetable (see below).

Timetable

The full timetable for lectures, tutorials, and practical classes can be accessed on the BIOS1171 online eLearning site (https://elearning.sydney.edu.au).

Week	Lecture Tues 2-3pm	Lecture Wed 1-2pm	Lecture Wed 2-3pm	Pracs/Tutes Thurs 9-11, 11-1, 1-3, 3-5pm
1	Basic structure 1	Basic structure 2	Basic structure 3	Basic structure
1	Online self-directed learning Bio-electricity (must study before week 2)			
2	Spinal cord	Brainstem	Membrane potential	Spinal cord
3	Action potential	Cranial nerves	Synapse 1	Brainstem, cranial nerves Basic function 1
4	Cerebral hemispheres	Cortical structure	Sensory pathways	Cerebral hemispheres Basic function 2
5	Synapse 2 Somatosensation 1	Somatosensation 2	Pain	Somatosensation
6	Visual system structure	Vision	Auditory/vestibular structure	Sensory pathways Basic function 3
7	**Public holiday**	**Mid-semester exam**		Pain Special senses: structure
8	Auditory/vestibular function	Stretch reflex	Multisynaptic reflexes	Special senses: function
9	Motor unit	Posture 1	Posture 2	Reflexes
10	Corticospinal 1	Blood supply 1	Blood supply 2	Blood supply Motor control 1: spinal cord injury
11	Corticospinal 2	Cerebellum 1	Cerebellum 2	Cerebellum Motor control 2: stroke
12	Cerebellum 3	Basal ganglia 1	Basal ganglia 2	Basal ganglia Motor control 3: Lesion of basal nuclei
13	Basal ganglia 3	Autonomic structure	Autonomic function	Autonomic nervous system Plasticity

Lecture recordings

The Discipline of Biomedical Science will record lectures in accordance with university policies. Recordings may not be made if recording facilities are unavailable, non-operational in the lecture venue, or if the lecturer exercises their right not to be recorded. From time to time, delays in lecture uploading may occur. Because lectures are recorded remotely, neither the individual lecturer nor the Discipline of Biomedical Science have control over lecture uploading.

Students should not rely on recordings to replace face-to-face classes.

Assessment

The examinable material in this unit consists of all content presented in the lectures, self-directed learning module, tutorials, and practical classes. There will be four assessments, two of which will contribute to your final result. The timing, format, and contribution of the assessments are as follows.

Assessment	Week	Duration	Format	Contribution to final result
Mid-semester self-test	6	Variable	Online self-test	0%
Mid-semester examination	7	Approximately 1 hour and 20 minutes	Multiple-choice questions	40%
End-semester self-test	13/14	Variable	Online self-test	0%
End-semester examination	15/16	2 hours (plus 10 minutes reading time)	Multiple-choice questions	60%

You will find it difficult to reach a satisfactory standard if you leave your study until the last minute. Only if you learn your work as it is presented will you be able to use the simpler early material to assist in understanding the more complex later material.

Online self-test assessments

During the semester, you will be given online self-test assessments. These assessments will not count towards your final grade in the unit. However, you are advised to treat each assessment as if it were formal. After studying the topics in detail, do the assessment without interruption and without looking up the answers in your notes or textbooks. In this way you will gain an indication of how satisfactory your study has been and of which areas need more attention.

Mid-semester examination

- The *Bioelectricity* self-directed tutorial is examinable.
- All lecture content presented in weeks 1 to 5 inclusive is examinable.
- All tutorial and practical content presented in weeks 1 to 6 inclusive is examinable.
- Venue: please check the Timetable link on the eLearning site closer to the date.
- What to bring: pencils (preferably 2B), an eraser, and your student ID card. A calculator is not required.

End-semester examination

- All lecture content presented in weeks 6 to 13 inclusive is examinable.
- All tutorial and practical content presented in weeks 7 to 13 inclusive is examinable.
- Materials covered in the mid-semester examination provide a foundation for later material, and may therefore be examined indirectly.

Assessment policy and procedures

It is your responsibility to be available for all assessments. You are required to be present at the correct time and place. Misreading or misunderstanding of the time and/or the location of an assessment will not be accepted as a reason for failure to attend an assessment.

Grading procedure

The scores in the two examinations will be weighted by their contributions (40% and 60%) and summed to provide the final score. The final scores will then be segregated into grades, as follows.

Final score (%)	Grade	Grade name
0 – 49	FA	Fail
50 – 64	PS	Pass
65 – 74	CR	Credit
75 – 84	DI	Distinction
85 – 100	HD	High Distinction

Grades represent the following abilities.

Fail

- Limited knowledge and understanding of the learning materials.

Pass

- A basic knowledge and understanding of the learning material.
- Some ability to source and use appropriate learning resources.

Examples of Pass level questions are shown below:

1. Which of the following statements is correct?

    a) Peripheral nerves contain somatosensory afferents.
    b) Pia mater supports individual nerve fibres.
    c) Ganglion cell bodies lie in the distal part of the peripheral nerve.
    d) Cell bodies of motor neurons are found close to the muscle.

2. Which of the following is not involved in a monosynaptic reflex arc?

    a) afferent neuron
    b) central synapse
    c) interneuron
    d) efferent neuron

3. The primary somatosensory cortex is part of which lobe?

    a) frontal
    b) occipital
    c) parietal
    d) temporal

4. When an excitatory axon is stimulated repeatedly at high frequency, the excitatory postsynaptic potentials on the postsynaptic neuron have an additive effect. This is called:

    a) temporal facilitation or temporal summation.
    b) spatial facilitation or spatial summation.
    c) reverberating excitation.
    d) convergent excitation.

Credit

- A sound knowledge and understanding of the course concepts and learning materials.
- Ability to source appropriate learning resources and apply key concepts of the subject matter to familiar situations.

Examples of Credit level questions are shown below:

5. Which of the following statements is correct?

    a) The trigeminal nerve supplies muscles of the face.
    b) The reticular formation relays direct inputs to the cerebral cortex.
    c) The auditory cortex is located in the superior temporal gyrus.
    d) The thalamus is responsible for endocrine functions.

6. A potential difference of 3 volts between two points means that:

    a) there is a force of 3 newtons between 1 coulomb charges placed at the two points.
    b) each joule of energy needs 3 coulombs of charge to carry it between the points.
    c) each coulomb of charge gains or loses 3 joules of energy when it moves between the points.
    d) there is a difference of 3 amps of current as 1 coulomb of charge moves between the points.

7. Which of the following is the result of increased parasympathetic system activity?

    a) increased heart rate
    b) increased stroke volume of heart
    c) increased gastric secretions
    d) constriction of skin blood vessels

Distinction

- A solid knowledge and understanding of course concepts and learning materials.
- Initiative and ability to source and apply key concepts of the subject matter to familiar situations in a novel manner.

Examples of Distinction level questions are shown below:

8. Which of the following statements is incorrect?

    a) The olfactory bulb projects to the temporal lobe of the cortex.
    b) The facial nerve carries sensory information from facial skin.
    c) The dorsal column comprises first-order neurons.
    d) The oculomotor nerve is found at the pons-midbrain junction.

9. Treatment of a nerve cell with a drug which blocks Na^+/K^+ pump would:

    a) reduce the resting membrane potential to zero in a few milliseconds.
    b) inhibit the active pumping of sodium into the cell.
    c) cause a slow increase in the intracellular concentration of sodium.
    d) result in gradual hyperpolarisation of the cell membrane.

10. The final common pathway is a functional term for:

    a) upper motor neurons.
    b) all motor neurons.
    c) somatic motor neurons which project primarily to extrafusal fibres.
    d) converging afferent projections at primary somatosensory cortex.

High Distinction

- A comprehensive knowledge and understanding of course concepts and learning materials.
- Outstanding initiative and ability to source, integrate and apply subject knowledge to novel situations.

How well do you need to do to achieve a particular grade? In previous years, students who correctly answered the above questions generally obtained the stated grade or a higher one.

Communication policies

Blackboard site

This unit of study requires you to use the BIOS1171 Neuroscience online eLearning site (https://elearning.sydney.edu.au) to access information or complete assessments. Materials on the site include: the unit of study outline, objectives, timetable, lecture notes, practical and tutorial notes, bioelectricity, supporting materials and discussion forum.

Students should access the eLearning site at regular intervals.

You are encouraged to use the discussion forum to discuss material covered in the unit of study. Lecturers may monitor these discussions but will not contribute to them. Difficulties related to the content should be addressed to the corresponding lecturer, tutor or demonstrator.

Help for logging in to eLearning is at: http://sydney.edu.au/elearning/student/gettingStarted/login.shtml.
ICT helpdesk links can be found at: http://sydney.edu.au/ict/contact/helpdesk.shtml.

Email

When communicating with teaching staff the most straight forward method is via email. Note the following guidelines when emailing staff.

- Use your University email address
- Address the person appropriately
- Identify yourself by name and SID
- Identify the unit of study that you are enquiring about
- Word your email clearly

Due to concerns about viruses, emails that are anonymous, contain unsolicited attachments, or are from a non-University address are unlikely to be opened or read.

Academic honesty

While the University is aware that the vast majority of students and staff act ethically and honestly, it is opposed to and will not tolerate academic dishonesty or plagiarism and will treat all allegations of dishonesty seriously.

All students are expected to be familiar and act in compliance with the relevant University policies, procedures and codes, which include:
- *Academic Honesty in Coursework Policy 2015*
- *Academic Honesty Procedures 2016*
- *Code of Conduct for Students*
- *Research Code of Conduct 2013* (for honours and postgraduate dissertation units)

They can be accessed via the University's Policy Register: http://sydney.edu.au/policies (enter "Academic Honesty" in the search field).

Students should never use document-sharing sites and should be extremely wary of using online "tutor" services. Further information on academic honesty and the resources available to all students can be found

on the Academic Integrity page of the University website:
http://sydney.edu.au/elearning/student/EI/index.shtml

Academic Dishonesty and Plagiarism

Academic dishonesty involves seeking unfair academic advantage or helping another student to do so.

You may be found to have engaged in academic dishonesty if you:

- Resubmit (or "recycle") work that you have already submitted for assessment in the same unit or in a different unit or previous attempt;
- Use assignment answers hosted on the internet, including those uploaded to document sharing websites by other students.
- Have someone else complete part or all of an assignment for you, or do this for another student.
- Except for legitimate group work purposes, providing assignment questions and answers to other students directly or through social media platforms or document ("notes") sharing websites, including essays and written reports.
- Engage in examination misconduct, including using cheat notes or unapproved electronic devices (e.g., smartphones), copying from other students, discussing an exam with another person while it is in progress, or removing confidential examination papers from the examination venue.
- Engage in dishonest plagiarism.

Plagiarism means presenting another person's work as if it is your own without properly or adequately referencing the original source of the work.

Plagiarism is using someone else's ideas, words, formulas, methods, evidence, programming code, images, artworks, or musical creations without proper acknowledgement. If you use someone's actual words you must use quotation marks as well as an appropriate reference. If you use someone's ideas, formulas, methods, evidence, tables or images you must use a reference. You must not present someone's artistic work, musical creation, programming code or any other form of intellectual property as your own. If referring to any of these, you must always present them as the work of their creator and reference in an appropriate way.

Plagiarism is always unacceptable, regardless of whether it is done intentionally or not. It is considered dishonest if done knowingly, with intent to deceive or if a reasonable person can see that the assignment contains more work copied from other sources than the student's original work. The University understands that not all plagiarism is dishonest and provides students with opportunities to improve their academic writing, including their understanding of scholarly citation and referencing practices.

USE OF SIMILARITY DETECTION SOFTWARE

All written assignments submitted in this unit of study will be submitted to the similarity detecting software program known as **Turnitin**. Turnitin searches for matches between text in your written assessment task and text sourced from the Internet, published works and assignments that have previously been submitted to Turnitin for analysis.

There will always be some degree of text-matching when using Turnitin. Text-matching may occur in use of direct quotations, technical terms and phrases, or the listing of bibliographic material. This does not mean you will automatically be accused of academic dishonesty or plagiarism, although Turnitin reports may be used as evidence in academic dishonesty and plagiarism decision-making processes.

Special consideration

What it means to receive Special Consideration

- If you apply and receive approval for Special Consideration prior to the examination, you do not sit for the normal examination and you will be required to sit a Replacement Assessment*.
- If you apply and receive approval for Special Consideration after the examination and did not sit the examination, you will be required to sit a Replacement Assessment*.
- If you apply and receive approval for Special Consideration after sitting the examination, your exam paper for the normal examination will not be marked and you will be required to sit a Replacement Assessment*.

* You must make yourself available at the University's Replacement Assessment periods.

- Mid-semester Replacement Assessments: Week 13.
- End-semester Replacement Assessments: Week 18.

Please Note:

- No alternative arrangements are available.
- There will be changes in the replacement examination questions from those in the original examination.
- The replacement exam may not cover the same topics as the exam that was impacted, but will test the same learning outcomes. Other factors (such as the length, duration or structure of the exam) may also be different.

Applying for Special Consideration

Please visit the following website for information and application form:

https://sydney.edu.au/current_students/special_consideration/index.shtml

Student appeals

Student appeals: academic and administrative

A student may appeal against a mark or grade for either a single assessment, or the final assessment for a whole unit of study. Students are encouraged to consult with their unit of study coordinator in the first instance.

A student may appeal against an administrative decision. More information can be found here:
http://sydney.edu.au/health-sciences/current-students/coursework/appeals.shtml

Available IT services for students

Computer access

All Students are given a *UniKey* account that lets them access IT (internet) services around the university. The University Computer Access Labs provide students and staff members of The University of Sydney with access to computers. These labs give students and staff access to printing, scanning, internet access, word processing, and expert staff assistance.

On the Cumberland Campus, computer labs are located on level 2 of Building B, in Room B107. **Opening hours:** *During Semester***:** Monday - Friday 7:30am - 10:00pm, *During Vacation*: Monday - Friday, 7:30am - 6:00pm, **Staff available:** Monday to Friday 7:30am - 3:30pm.
http://sydney.edu.au/ict/student/locations/cumberland.shtml

Response to student feedback

Student feedback, gathered through surveys and other sources, have been incorporated into lectures, practical classes and tutorials.

Student support

Student Central

provides prospective and enrolled students with information and advice on the various courses offered by the Faculty of Health Sciences, manages student records and administers admissions, enrolment, examinations and graduations. The Student Central Office is located in Block F (next door to the Depot), Cumberland Campus and is open Monday to Friday, 9:00am to 5:00pm.
http://sydney.edu.au/health-sciences/current-students/

Counseling Service (free and confidential):

On the Cumberland Campus you can find the Counseling Services office on the Ground Floor in Building A.
Telephone: (02) 9351-9638, **Facsimile:** (02) 9351-9635
E-mail: cumberland.cs@sydney.edu.au
http://sydney.edu.au/current_students/counselling/

International Student Services Unit

(provides an integrated counseling and welfare service to international students):
Telephone: (02) 8627 8300, **Facsimile:** (02) 8627 8387
E-mail: io.mail@sydney.edu.au
http://sydney.edu.au/internationaloffice/

Disability Services Office

(provides information and assistance):
Enquiries: (02) 8627 8422, **Appointments:** (02) 8627 8422
Facsimile: (02) 8627 8482
Email: ds.cumberland@stuserv.usyd.edu.au,
http://sydney.edu.au/stuserv/disability/

THE UNIVERSITY OF SYDNEY

SYDNEY MEDICAL SCHOOL

Discipline of Biomedical Science

Neuroscience
BIOS1171

Objectives
Semester 1, 2017

Name:

BIOS1171 Objectives

Objectives

On completion of this unit of study, you should be able to do the following.

1. Basic structure

1.1. Basic anatomy of the nervous system

1. Identify the divisions and functions of the nervous system.
2. Identify the components and functions of a neuron.
3. Classify neurons in terms of structure and function.
4. Describe the role of myelin and identify cells responsible for the production of myelin.
5. Identify the components and functions of a synapse.
6. Classify synapses in terms of structure and function.
7. Describe the components of a simple reflex.
8. Describe different types of glial cells.
9. Identify structures that support and protect the central and peripheral nervous system.
10. Describe the formation and functions of cerebrospinal fluid.
11. Describe the circulation of cerebrospinal fluid through the ventricles and means of return to the major sinuses.
12. Describe the segmental organisation of the spinal cord and spinal nerves.
13. Identify spinal rami, roots, and named nerves (*e.g.* median nerve).
14. Know the basis of dermatome and myotome distribution.
15. Describe the structure and function of neuromuscular junctions.

1.2. Structure and role of the spinal cord

1. Describe the location and orientation of the spinal cord.
2. Identify the structures that protect the spinal cord.
3. Identify the external structures of the spinal cord.
4. Identify the internal structures within the spinal cord.
5. Differentiate grey and white matter and understand that the ratio between them changes along the length of the spinal cord.
6. Understand the organisation and naming of spinal nerves.
7. Name the number of segments in each portion of the spinal cord.
8. Know the sensory modalities carried by the spinal cord.

1.3. Basic components of the diencephalon, brainstem and cranial nerves

1. Identify and describe the functions of diencephalon and its components: thalamus, hypothalamus, subthalamus and epithalamus.
2. Identify brainstem and its components: midbrain, pons and medulla.
3. Describe the functions of midbrain, pons and medulla.
4. Describe the relationship between diencephalon and brainstem.
5. Describe the naming and organisation of cranial nerves.
6. Describe the location and functions of each cranial nerve.
7. Understand clinical symptoms following a lesion to each cranial nerve.

1.4. Structure and role of the cerebral hemispheres

1. Identify major divisions of the cerebral hemispheres.
2. Identify external structures of the brain using anatomical criteria.
3. Simply describe the imaging techniques (*e.g.* PET, MRI) used to investigate the cerebral cortex.
4. Identify external structures of the brain using functional criteria.
5. Understand main clinical symptoms following damages to part of the cortex (*e.g.* prefrontal area, Broca's area or Wernicke's area).
6. Identify structures in horizontal, coronal and sagittal brain slices.
7. Define somatotopy and its relevance to cortical organisation.
8. Describe the organisation and function of commissural, projection, and association neurons.

BIOS1171 Objectives

1.5. Structure of the cerebral cortex

1. Understand the key foetal periods of cortical development including the development of cortical columns, layering and myelination.
2. Describe the functions of cortical layers and the basis for Brodmann's areas.
3. Describe the classification of cortical afferents and efferents.
4. Identify the location, Brodmann's areas and function of the primary, secondary and association areas for somatosensory, auditory and visual cortical function.

1.6. Structure and role of the long somatosensory pathways

1. Describe the basic organisational pattern of sensory pathways.
2. Describe the functional organisation of the spinothalamic pathway.
3. Describe the functional organisation of the dorsal column-medial lemniscal pathway.
4. Describe the organisation and processing of sensory inputs from the head and face.

2. Basic function

2.1. Membrane potential and action potential

1. Understand the following concepts of bioelectricity: charge, Coulomb's Law, potential difference, current, Ohm's Law, conductance, capacitance.
2. Describe the concentration of important ions inside and outside the neuron.
3. Describe the opposing forces that create equilibrium at rest.
4. Define and quantify the resting membrane potential.
5. Know the membrane protein responsible for the maintenance of the concentration gradients.
6. Define sodium channel activation and its effects on the membrane potential.
7. Describe the ion conductance changes underlying the depolarising and repolarising phase of the action potential.
8. Define threshold voltage, absolute refractory period, and relative refractory period.
9. Explain how the positive feedback cycle leads to conduction in axons.
10. Define saltatory conduction.
11. Know examples of myelinated and unmyelinated axons, and their conduction velocities.

2.2. Synapse

1. List the presynaptic and postsynaptic steps involved in transmission at a synapse.
2. Explain the effect of an excitatory postsynaptic potential and inhibitory postsynaptic potential on membrane potential.
3. Define the spatial and temporal summation of postsynaptic potentials.
4. Explain the need for summation effects in generating the action potential.
5. Know the functional differences between neuromuscular junctions and other synapses.
6. Describe some elementary neural circuits that include both excitatory and inhibitory synapses.

3. Sensory processes

3.1. Somatosensation

1. List the role of receptors in determining information entering the nervous system.
2. Define adequate stimulus and sensory modality.
3. Describe somatosensory endings.
4. Compare the sensitivity and function of superficial and deep mechanoreceptors.
5. State the type of information carried by nerve endings.
6. State the types of afferent fibres in a cutaneous nerve with respect to axon diameter.
7. Know the receptor potential location on the ending and its role.
8. Define receptor adaptation, and describe its benefits.
9. Define somatosensory modality in terms of the type of information carried.
10. Describe the origin and termination of the neurons comprising the dorsal column pathway and the general nature of the information carried.
11. Describe the origin and termination of the neurons comprising the anterolateral pathway and the general nature of the information carried.
12. Describe the sensory processes occurring in the postcentral gyrus.

13. Explain the effect on sensation due to a lesion that prevents information from reaching the postcentral gyrus.

3.2. Pain

1. Describe the neural processes involved in pain sensation.
2. Describe the functional types of nociceptors and their response profile.
3. Describe the afferent nociceptive pathways.
4. Describe referred pain.
5. Define phantom limb pain.
6. Describe the endogenous opioid peptides.
7. Describe the gate control mechanism for pain transmission.
8. Describe the role of peri-aqueductal grey in the pain modulation process.
9. Explain the mechanism of sensitisation.
10. Explain the mechanisms of primary and secondary hyperalgesia.
11. Describe the clinical features of neuropathic pain.

3.3. Structure of the visual system

1. Identify and understand the general functions of the external and internal structures of the eye.
2. Describe the location and functional significance of the fovea (or fovea centralis), macula lutea and optic disc.
3. Describe the production, location and circulation of aqueous humour.
4. Describe the location, function and nervous control of the pupil and lens.
5. Describe the location, functions and innervation of extraocular muscles.
6. Describe the location and blood supply of the retina.
7. Describe the main layers of cells that form the retina.
8. Describe the visual pathway from photoreceptors to primary visual cortex.

3.4. Function of the visual system

1. Describe the optical components of the eye, and common optical errors.
2. Describe the photoreceptors in terms of: their distribution, synaptic connections and photopigments; visual acuity; sensitivity; activation; role in colour vision.
3. Discuss the functional significance of the visual pathways and describe common visual field defects.

3.5. Structure of the auditory system

1. Identify the boundaries of the outer, middle and inner ear.
2. Identify the structures of the outer, middle and inner ear.
3. Understand the bilateral pattern within the central auditory pathway.
4. Describe the role of the medial geniculate nucleus and auditory cortex.

3.6. Function of the auditory system

1. Describe the function of the outer, middle, and inner ear.
2. Describe the transduction process in hair cells.
3. Describe the physiological equivalents of loudness and pitch.

3.7. Structure of the vestibular system

1. Describe the location of the bony and membranous labyrinth in the vestibular system and their anatomical relationship.
2. Identify the location of the utricle, saccule and semicircular canals.
3. Describe the location, structure and function of receptors including maculae, ampullae, hair cells, otoliths and vestibular nerve.
4. Describe connections of the main vestibular pathways both within the brainstem and spinal cord.

3.8. Function of the vestibular system

1. Describe the mechanism of maintenance of equilibrium (balance) in terms of: receptors in the vestibular apparatus; movement of the endolymph.

2. Discuss the functional significance of the central connections of the vestibular apparatus in terms of maintenance of equilibrium, co-ordinated muscle activity, control of eye movements, and the conscious appreciation of position and movement.

4. Spinal reflexes

1. Define the components of the stretch reflex and their connections.
2. Understand the structure of the muscle spindle and its role.
3. Understand the differences in role and innervation of extrafusal and intrafusal muscle fibres.
4. Define the roles of alpha and gamma motor innervations to the spindle.
5. Understand the difference in the pathways producing agonist and antagonist stretch effects and discuss reciprocal inhibition.
6. Understand and describe the function of the Golgi tendon reflex.

5. Motor systems

5.1. The motor unit

1. Understand the term *motor unit* and explain motor unit recruitment.
2. Describe the pattern of impulses arising from tonic and phasic inputs to the motor unit and describe the resulting muscle activity.
3. Compare properties of small and large motor units.
4. Define the term upper motor neuron.
5. Define a lower motor neuron and its role in the *final common pathway*.
6. Explain the role of the upper motor neuron in contributing drive to the final common pathway.

5.2. Muscle tone

1. Define muscle tone and describe how it is clinically assessed.
2. Describe the type of motor unit that contributes to tone, its activity pattern and describe the potential sources of neural input to these units.
3. Define factors that contribute to clinical hypertonia.
4. Describe the effects of lower motor neuron and upper motor neuron lesions on muscle tone, tendon reflex activity and voluntary muscle activity.

5.3. Role of the postural system

1. Define posture and describe the roles of the postural system in the stationary body and during movement.
2. Define the level of the central nervous system at which the postural and movement upper motor neurons originate and the implications for control of posture.
3. Define the role of the lower motor neurons in the control of posture and movement.

5.4. Descending motor pathways

1. Describe the origin, pathway and termination of each of the four major descending motor tracts in the brain.
2. Compare and contrast the influence of each of these pathways on limb muscles, posture and movement.
3. Describe the role of the vestibular system in eye and head movements.
4. Describe the initial stimulus, afferents and receptor types, for the righting reflex.

5.5. Decerebrate and decorticate rigidity

1. Define and describe a decerebrate lesion and its effects.
2. Define and describe a decorticate lesion and its effects.

5.6. Motor cortex – functional areas and organisation

1. Identify sources of input to the primary motor cortex.
2. Describe how the corticospinal tract leads to muscle activation.
3. Compare the prefrontal, premotor and primary motor cortex in terms of their input and output connections, order of activation in planning and execution of voluntary tasks and the effects of damage on motor behaviour.

5.7. Basic anatomical structure and relationships of the cerebellum

1. Know the location of the posterior cranial fossa and the disposition of the cerebellum within that cavity.
2. Know the relationship of the cerebellar peduncles to the cerebellum.
3. Describe the following for the cerebellum: vermis, hemispheres, flocculi; features of the superior and inferior surface.
4. Know the functional divisions of the cerebellum: vermis, flocculonodular lobe, paravermal zone (intermediate lobe), lateral hemispheres.
5. Know the basic connections for each functional area of the cerebellum.

5.8. Cerebellum

1. Describe the pathway whereby a coordinating centre can influence muscle activity.
2. Identify three functional areas in the cerebellum and outline their anatomical boundaries.
3. Define the input into each functional area and the output connecting motor centres.
4. Define the function of the deep cerebellar nuclear cells.
5. Identify the feedback and feedforward mechanisms in which the cerebellum can regulate movement of the upper limbs and balance.
6. Identify the pathway for control of eye movements by the vestibulocerebellum.
7. Explain the *error signal*.
8. Describe the changes in balance control occurring after a lesion to the vestibulocerebellum.
9. Note the main source of input to the lateral hemisphere of the cerebellum, and compare it with the vermis and flocculonodular lobe.
10. Describe the role of the cerebrocerebellum in cognition.
11. Describe the process in which a cerebellar lesion can lead to ataxia, decomposition of movements, dysmetria and intentional tremor.

5.9. Basal ganglia/nuclei

1. Describe the components and anatomical location of the basal ganglia/nuclei.
2. Describe the location and immediate relationships of the basal ganglia/nuclei associated with motor function.
3. Describe the net effect of basal ganglia/nuclei activity on voluntary movement.
4. Define the purpose of this influence on normal posture and movements.
5. Describe the effect of a substantia nigra lesion on the thalamus and predict the effect of this lesion on normal posture and movement.

6. Blood supply

1. Understand the location and major branches of the vertebral and internal carotid arteries.
2. Understand the arterial blood supply of the major regions of the brainstem, cerebellum and cerebral cortex.
3. Describe the arrangement and major areas of supply of deep cerebral arterial branches.
4. Describe the pattern of venous blood flow from capillaries, through veins, to sinuses.
5. Identify the location of major sinuses.
6. Describe major pathologies leading to loss of blood supply to the central nervous system.

7. Autonomic nervous system

1. Explain the general role of the autonomic nervous system.
2. Explain why the autonomic nervous system is divided into two components: sympathetic and parasympathetic.
3. Describe the components of the sympathetic and parasympathetic nervous system and the general function of each.
4. Describe the effectors innervated by the autonomic nervous system.
5. List the differences between the autonomic nervous system and somatic nervous system.
6. Compare the effects of sympathetic and parasympathetic activity.
7. List the transmitter substances liberated by sympathetic and parasympathetic endings.
8. Describe the postsynaptic receptors upon which the transmitters act.