1495 UNIVERSITY OF ABERDEEN

BI20B2- Physiology of Human Cells

Course Handbook 2023-2024

School of Medicine, Medical Sciences & Nutrition

Undergraduate Medical Sciences

Contents

Course Summary

This course introduces you to human physiology – the understanding of body function. The central concept, essential to physiology, is homeostasis – the maintenance of a relatively constant internal environment in a constantly changing external environment. This course (along with its partner BI25B2) will consider how this is achieved at cell and whole-body level. The focus in this course will be on the roles of the nervous and endocrine control systems. Specifically, it deals with: the physiology of the cell with special reference to nerve and muscle; cell-cell signalling; neuro-endocrine integration and some aspects of endocrinology; membrane potentials and action potentials in nerve cells; reflexes; central nervous system control of movement; the physiology and pharmacology of the autonomic nervous system; transduction of sensory information by receptors and processing of sensory information by the CNS; The composition and function of blood including its role in immunity.

Course Aims & Learning Outcomes

1. This course aims to develop an understanding of the main 'integrating' systems of the body, the nervous system and the endocrine system, and to enable students to become confident in practical laboratory skills and computer data-handling.

2. To understand the principles of cellular and organismal homeostasis.

3. To describe the principal components of animal cells and discuss their contributions to cell homeostasis and function.

4. To explain the mechanisms of transport across animal cell membranes and discuss their roles in the regulation of cellular homeostasis.

5. To define the processes used to achieve cell-cell signalling and discuss their role in providing variability of response and function.

6. To describe the endocrine system and evaluate its inter-relationships with the nervous system.

7. To describe the organisation of the nervous system and explain the principles of action potential conduction.

8. To explain the excitation and contraction of skeletal, cardiac and smooth muscle.

9. To describe simple spinal reflexes and their functions.

10. To explain the fine control of movement through the central nervous system.

11. To describe the organisation and functions of the autonomic nervous system and explain the role of this system in controlling the internal organs of the body.

12. To explain the transduction of sound, other mechanical stimuli, chemicals and light by various sensory receptors, and discuss how sensory information is passed to the central nervous system.

13. To introduce the principal functions of blood, to discuss its importance for nervous and endocrine function and to discuss its role in the defence against pathogenic micro-organisms.

Course Teaching Staff

Course Coordinator:

- Dr Catriona Cunningham (**catriona.cunningham@abdn.ac.uk**)

Other Staff:

- Dr Guy Bewick (**g.s.bewick@abdn.ac.uk**)
- Dr Isabel Crane (**i.j.crane@abdn.ac.uk**)
- Dr Alison Jack (**a.jack@abdn.ac.uk**)
- Dr Pietro Marini (**p.marini@abdn.ac.uk**)
- Dr Iain Rowe (**iain.rowe@abdn.ac.uk**)
- Dr Derryck Shewan (**d.shewan@abdn.ac.uk**)
- Prof Steve Tucker (**s.j.tucker@abdn.ac.uk**)

Assessments & Examinations

You are expected to access and study **all** lectures, laboratory classes and online test materials, and to complete all class exercises by given deadlines. The minimum performance acceptable for the granting of a class certificate is evidence of engagement with, at least, 75% of the lectures and lab classes, and presentation of all set coursework. Failure to achieve this may result in your class certificate being withheld.

The course assessment consists of 2 submitted laboratory reports (both 20%) and 2 course tests (20% mid-term and 40% final). Resit assessment will be based on a resit examination constituting 60% of the resit grade; the remaining 40% will come from the laboratory reports. Your overall performance will be expressed as a grade awarded on the common grading scale (CGS).

Class Representatives

We value students' opinions in regard to enhancing the quality of teaching and its delivery; therefore, in conjunction with the Students' Association we support the Class Representative system.

In the School of Medicine, Medical Sciences & Nutrition we operate a system of course representatives, who are elected from within each course. Any student registered within a course that wishes to represent a given group of students can stand for election as a class representative. You will be informed when the elections for class representative will take place.

What will it involve?

It will involve speaking to your fellow students about the course you represent. This can include any comments that they may have. You will attend a Staff-Student Liaison Committee and you should represent the views and concerns of the students within this meeting. As a representative, you will also be able to

contribute to the agenda. You will then feedback to the students after this meeting with any actions that are being taken.

Training

Training for class representatives will be run by the Students Association. Training will take place within each half-session. For more information about the Class representative system visit www.ausa.org.uk or email the VP Education & Employability vped@abdn.ac.uk . Class representatives are also eligible to undertake the STAR (Students Taking Active Roles) Award with further information about this co-curricular award being available at: www.abdn.ac.uk/careers.

Problems with Coursework

If students have difficulties with any part of the course that they cannot cope with, alone they should notify the course coordinator immediately. If the problem relates to the subject matter general, advice would be to contact the member of staff who is teaching that part of the course. Students with registered disabilities should contact the medical sciences office, (medsci@abdn.ac.uk) (based in the Polwarth Building, Foresterhill) to ensure that the appropriate facilities have been made available. Otherwise, you are strongly encouraged to contact any of the following as you see appropriate:

- Course student representatives
- Course co-ordinator
- Personal tutor
- Medical sciences disabilities co-ordinator (Dr Derryck Shewan)

All staff are based at Foresterhill but teach across both campuses. If you wish to meet with a staff member, we strongly recommend you email them to arrange a suitable time and place. This is to avoid making a wasted journey up to Foresterhill to find they are not there.

Course Reading List

Recommended text for course:

Silverthorn D.U. – Human Physiology; An Integrated Approach 8th Edition 2019, Pearson. ISBN 978-1-292-25954-3 (also available online from library – see course MyAberdeen site)

Lecture Synopsis

Lecture 1: Introduction to the course. - Dr Catriona Cunningham

Lecture 2: What is Physiology? - Dr Iain Rowe

Physiology is concerned with functions of living matter. This includes a hierarchical organisation from cells to tissue to organs to systems. These principal building blocks will be introduced together with the concept of homeostasis.

Lecture 3: Membrane Transport 1. Movement across membranes - Dr Iain Rowe

Introduction to the structural organisation of the cell, the functions of the organelles and some principles of energy metabolism. Energy is required to maintain gradients between compartments. Some principles of ion exchange across membranes will also be discussed.

Lecture 4: Membrane Transport 2. Membrane transport proteins and cellular homeostasis - Dr Iain Rowe

This lecture discusses multiple transport functions of the plasma membrane to maintain constant cell volumes, regulate intracellular calcium, and pump ions against their gradients. The origin of membrane potentials (especially for nerve cells) is also considered along with ion channel functioning.

Lecture 5-6: Cell Signalling 1 & 2 - Dr Iain Rowe

Communication between cells relies on specific signalling mechanisms such as paracrine, endocrine or synaptic signalling. The target cells express receptors through which information can be transduced in order to activate intracellular enzyme cascades (second messengers). This eventually leads to gene activation and expression of novel proteins.

Lecture 7: Introduction to Pharmacology – Dr Pietro Marini

A drug can be defined as any chemical (either natural or synthetic) which interacts with biological material to alter its function in some way. The discipline of Pharmacology deals with the interactions between drugs and cells, tissues and organs. Having considered the general mechanisms whereby chemical messengers mediate cell communication and signal transduction, this lecture will introduce the basic principles of pharmacology: receptors, agonists, antagonists, dose-response relationships.

Lecture 8: Hormones 1. General features of hormone actions - Prof Steve Tucker

Chemical agents travelling in the blood stream are hormones, which regulate the activity of the physiological system. Some general features of hormone actions and comparison of the 3 main chemical classes of hormones will be covered.

Lecture 9: Hormones 2. Pituitary and hypothalamus - Prof Steve Tucker

Pituitary gland and hypothalamus constitute the connection between nervous and endocrinal system. Anterior and pituitary gland function will be contrasted and details of the main hormones from each summarised. Endocrine axes, regulation and feedback loops/mechanisms will be discussed.

Lecture 10: Hormones 3. Growth hormones and thyroid - Prof Steve Tucker

Growth hormone exerts multiple direct and indirect actions and are crucial for regulating growth and metabolism. Dwarfism or indeed gigantism can result from dysfunction. The thyroid secretes T3 and T4, iodine containing hormones crucial for regulating metabolic rate and maturation of skeleton and central nervous system. Malfunctions like hypothyroidism and hyperthyroidism will also be discussed.

Lecture 11: Hormones 4. Adrenal hormones - Prof Steve Tucker
Adrenal glands secrete fast-acting catecholamines such as epinephrine and norepinephrine, which regulate rapid responses to stress/danger. They also produce corticoids, steroid hormones involved in long-term regulation of stress-response, electrolyte balance and sexual function. Aberrant production of these hormones results in characteristic syndromes, which illustrate the importance of their functions.

Lecture 12: Nerve cells & connections 1. Organisation of the nervous system and the resting membrane potential – Dr Catriona Cunningham
An understanding of how the nervous system works starts with recognising how it is organised and the cells which make it up. As you probably know, neurones exist to send electrical signals around the body and they do this by using three types of potentials. Part 3 of this lecture will discuss the first of these: the resting membrane potential.

Lecture 13: Nerve cells & connections 2. Axonal conduction- Dr Catriona Cunningham
Continuing on our discussion of how neurones send electrical signals, we will cover the ionic basis of graded potentials and action potentials. This will include a compare and contrast their properties. Finally, we will discuss the concept of synaptic integration: how the hundreds of inputs a neuron receives are added together to decide if it will fire an action potential.

Lecture 14: Nerve cells & connections 3. Synaptic transmission - Dr Catriona Cunningham
While action potentials are magical, they do conduct very slowly. In the first part of the lecture, we will discuss how they can be sped up with large diameter axons and myelination. Neurones usually talk to each other via synapses where the electrical signals are briefly turned into a chemical signal that is squirted onto the second cell and triggers a "new" electrical signal. Parts 2 and 3 will explore how these chemical synapses work.

Lecture 15: Nerve cells & connections 4. Reflexes - Dr Catriona Cunningham
Motor control is essential for normal bodily functions. We will discuss the hierarchical nature of control mechanisms aiding the motor system and specifically discuss the organisation of the spinal cord with respect to reflex arcs and postural control.

Lecture 16: Nerve cells & connections 5. Cortical control of movement - Dr Catriona Cunningham
Apart from the crude but fast reflexes, the CNS coordinates and modulates more sophisticated responses to external stimuli. Several brain structures participate in the fine control of movement. We will consider the motor cortex first and discuss its connections to the spinal cord and its physiology.

Lecture 17: Nerve cells & connections 6. Physiology of the autonomic nervous system - Dr Catriona Cunningham
The autonomic nervous system (ANS) regulates the internal environment of the body (homeostasis). The sympathetic division of the ANS is associated with "fight and flight" while its counter the parasympathetic nervous system is associated with “rest and digest”. Part 1 will focus on the anatomical organisation, neurotransmitters and receptors of the ANS. In the second part we will explore the mostly antagonistic functions of the sympathetic and parasympathetic divisions using examples including the heart, lungs and eye.

Lecture 18: Muscle 1. Cellular structure of skeletal muscle - Dr Guy Bewick
Light and electron microscopic structure. Distribution and function of the major muscle proteins (myosin, actin, tropomyosin, troponin etc.). Contraction cycle and the role of ATP. Ca ions and its role in excitation-contraction coupling.

Lecture 19: Muscle 2. Mechanical properties of skeletal muscle - Dr Guy Bewick
Isotonic and isometric contractions. Twitch and tetanus. Correlating the length-tension relationship with sarcomere length and the effect of load on the velocity of contraction. The metabolic basis of muscle activity, fatigue and recovery. The control of muscle tension; motor units; types of muscle fibres.

Lecture 20: Muscle 3. Smooth and Cardiac Muscle - Dr Guy Bewick
Smooth muscle: Cellular structure. Single unit and multi-unit types of organisation. Excitation-contraction coupling. Stimuli causing contractions. Mechanical properties. Cardiac muscle: Structure of the heart. The cardiac action potential and temporal relationship to contraction. Cellular structure of cardiac muscle cells. Excitation-contraction coupling and relaxation. The long refractory period. Length-tension relationship; rate and force of contraction. Summary/comparison of muscle types.

Lecture 21: Sensory systems 1. General features of the sensory systems - Dr Derryck Shewan
This lecture introduces some elementary features of sensory receptors, their transduction mechanisms in order to produce adequate stimuli and mechanisms for coding of stimulus intensity and duration.

Lecture 22: Sensory systems 2. The somatosensory system - Dr Derryck Shewan
Different receptor types are used to communicate information about touch, pressure, vibration and temperature to the body. The coupling of these receptors to the different afferent nerve fibres and their information processing in spinal cord and central nervous system is discussed.

Lecture 23: Sensory systems 3. Pain - Dr Derryck Shewan
Pain is a special case of somatosensory sensations. The central pain pathways in the medulla and midbrain are discussed together with different forms of pain such as referred pain, neuralgia or phantom limb.

Lecture 24: Sensory systems 4. Physiology of the eye and visual pathways - Dr Derryck Shewan
After a brief introduction into the organisation of the retina and the optic of the eye, we will discuss the physiology of blink and pupillary reflexes, highlight normal and abnormal mechanisms of focussing, describe physiology of visual acuity in the retina and establish the mechanisms of processing visual information and colour in the lateral geniculate body and the visual cortex.

Lecture 25: Sensory Systems 5. Physiology of the ear - hearing and balance - Dr Derryck Shewan
The structure of the auditory system is described with emphasis on the ear and the mechanisms of sound transduction in the cochlea. A complex network issues this information to the inferior colliculus and auditory cortex for processing and localisation. Hearing impairments include deafness or hearing loss. A second system associated with the ear is the vestibular organ, a complex membranous labyrinth aiding balance. Tilting movements lead to otolith displacements and may also signal accelerations or gravity.

Lecture 26: Sensory systems 6. The chemical senses - smell and taste - Dr Derryck Shewan
Organs of smell are located in the nose in a specific epithelial arrangement. Activation of cells uses receptors linked to second messenger cascades via G-protein activation. The limbic system is the main recipient of olfactory information in the brain. Taste is categorised into four modalities and, similar to the perception of smell, uses second messenger activation as the transduction mechanism.

Lecture 27: Blood & Defence 1. General features - Dr Alison Jack

The chemical and cellular composition of the blood will be discussed together with the process by which blood cells are formed. We will also consider some diagnostic tools associated with blood testing such as haematocrit and viscosity.

Lecture 28: Blood & Defence 2. Homeostasis, haemoglobin and disorders - Dr Alison Jack

This lecture will focus on blood homeostasis by which we mean the processes that occur inside blood vessels after injury that cause blood to clot and prevent blood loss. We will also look at the reciprocal process of fibrinolysis which is responsible for breaking down a clot after healing is complete. Finally we will consider how drugs such as aspirin and warfarin impact on this process.

Lecture 29: Blood & Defence 3. The immune system - Dr Isabel Crane

We will discuss the body's natural immune system and its response to infection or injury - namely inflammation. What triggers inflammation, how is it mediated and what good does it do? We will then compare this to the adaptive immune system - a sophisticated defence system which can remember and recognise the specific pathogens it has previously been exposed to.

University Policies

Students are asked to make themselves familiar with the information on key education policies, available **here**. These policies are relevant to all students and will be useful to you throughout your studies. They contain important information and address issues such as what to do if you are absent, how to raise an appeal or a complaint and how the University will calculate your degree outcome.

These University wide education policies should be read in conjunction with this programme and/or course handbook, in which School specific policies are detailed. These policies are effective immediately, for the 2023/24 academic year. Further information can be found on the **University's Infohub webpage** or by visiting the Infohub.

The information included in the institutional area for 2023-24 includes the following:

- Assessment
- Feedback
- Academic Integrity
- Absence
- Student Monitoring/ Class Certificates
- Late Submission of Work
- Student Discipline
- The co-curriculum
- Student Learning Service (SLS)
- Professional and Academic Development
- Graduate Attributes
- Email Use
- MyAberdeen
- Appeals and Complaints

Where to Find the Following Information:

C6/C7- University of Aberdeen Homepage > Students > Academic Life > Monitoring and Progress > Student Monitoriung (C6 & C7)

https://www.abdn.ac.uk/students/academic-life/student-monitoring.php#panel5179

Absences- To report absences you should use the absence reporting system tool on Student Hub. Once you have successfully completed and sent the absence form you will get an email that your absence request has been accepted. The link below can be used to log onto the Student Hub Website and from there you can record any absences you may have.

Log In - Student Hub (ahttps://www.abdn.ac.uk/studenthub/loginbdn.ac.uk)

Submitting an Appeal- University of Aberdeen Homepage > Students > Academic Life > Appeals and Complaints

https://www.abdn.ac.uk/students/academic-life/appeals-complaints-3380.php#panel2109

Academic Language & Skills support

For students whose first language is not English, the Language Centre offers support with Academic Writing and Communication Skills.

Academic Writing

- Responding to a writing task: Focusing on the question
- Organising your writing: within & between paragraphs
- Using sources to support your writing (including writing in your own words, and citing & referencing conventions)
- Using academic language
- Critical Thinking
- Proofreading & Editing

Academic Communication Skills

- Developing skills for effective communication in an academic context
- Promoting critical thinking and evaluation
- Giving opportunities to develop confidence in communicating in English
- Developing interactive competence: contributing and responding to seminar discussions
- Useful vocabulary and expressions for taking part in discussions

Medical Sciences Common Grading Scale

Grade	Grade Point	% Mark	Category	Honours Class	Description
A1	22	90-100	Excellent	First	• Outstanding ability and critical thought • Evidence of extensive reading • Superior understanding •The best performance that can be expected from a student at this level
A2	21	85-89			
A3	20	80-84			
A4	19	75-79			
A5	18	70-74			
B1	17	67-69	Very Good	Upper Second	• Able to argue logically and organise answers well • Shows a thorough grasp of concepts • Good use of examples to illustrate points and justify arguments • Evidence of reading and wide appreciation of subject
B2	16	64-66			
B3	15	60-63			
C1	14	57-59	Good	Lower Second	• Repetition of lecture notes without evidence of further appreciation of subject • Lacking illustrative examples and originality • Basic level of understanding
C2	13	54-56			
C3	12	50-53			
D1	11	47-49	Pass	Third	• Limited ability to argue logically and organise answers • Failure to develop or illustrate points • The minimum level of performance required for a student to be awarded a pass
D2	10	44-46			
D3	9	40-43			
E1	8	37-39	Fail	Fail	• Weak presentation • Tendency to irrelevance • Some attempt at an answer but seriously lacking in content and/or ability to organise thoughts
E2	7	34-36			
E3	6	30-33			
F1	5	26-29	Clear Fail	Not used for Honours	• Contains major errors or misconceptions • Poor presentation
F2	4	21-25			
F3	3	16-20			
G1	2	11-15	Clear Fail/Abysmal		• Token or no submission
G2	1	1-10			
G3	0	0			

Course Timetable BI20B2: 2023-2024

Date	Time	Place	Subject	Session	Staff
Week 8					
Mon 18 Sep					
Tue 19 Sep	14:00-15:00	Arts Lecture Theatre	Introduction	Lecture	CC
Wed 20 Sep					
Thu 21 Sep	14:00-15:00	FN1	What is Physiology? Homeostasis	Lecture	IR
Fri 22 Sep	14:00-15:00	MacRobert LT	Membrane Transport 1	Lecture	IR
Week 9					
Mon 25 Sep					
Tue 26 Sep	14:00-15:00	Arts Lecture Theatre	Membrane Transport 2	Lecture	IR
Wed 27 Sep					
Thu 28 Sep	14:00-15:00	FN1	Cell Signalling 1	Lecture	IR
Fri 29 Sep	14:00-15:00	MacRobert LT	Cell Signalling 2	Lecture	IR
Week 10					
Mon 2 Oct					
Tue 3 Oct	14:00-15:00	Arts lecture theatre	Introduction to Pharmacology	Lecture	PM
Wed 4 Oct					
Thu 5 Oct	14:00-15:00	FN1	Hormones 1	Lecture	SJT
Fri 6 Oct	10:00-13:00	STH 1.001/ 1.007	Practical 1: Microscopy	Practical	CC/GSB/IR
	14:00-15:00	MacRobert LT	Hormones 2	Lecture	SJT
Week 11					
Mon 9 Oct					
Tue 10 Oct	14:00-15:00	Arts Lecture Theatre	Hormones 3	Lecture	SJT
Wed 11 Oct					
Thu 12 Oct	14:00-15:00	FN1	Hormones 4	Lecture	SJT
Fri 13 Oct	14:00-15:00	MacRobert LT	Nerve Cells & Connections 1	Lecture	CC
Week 12					
Mon 16 Oct					
Tue 17 Oct	14:00-15:00	Arts Lecture Theatre	Nerve Cells & Connections 2	Lecture	CC
Wed 18 Oct					
Thu 19 Oct	14:00-15:00	FN1	Nerve Cells & Connections 3	Lecture	CC
Fri 20 Oct	10:00-13:00	STH 1.001/ 1.007	Practical 2a: SIMNERV	Practical	CC/GSB/IR
	14:00-15:00	MacRobert LT	Mid-term Exam Information/Nerve Cells & Connections 4	Lecture	CC
Week 13					
Mon 23 Oct					
Tue 24 Oct	14:00-15:00	Arts Lecture Theatre	Nerve Cells & Connections 5	Lecture	CC
Wed 25 Oct					
Thu 26 Oct	14:00-15:00	FN1	Nerve Cells & Connections 6	Lecture	CC
Fri 27 Oct	10:00-13:00	STH 1.007/2.006	Practical 2b: SIMNERV Write-up	Practical	CC/GSB/IR

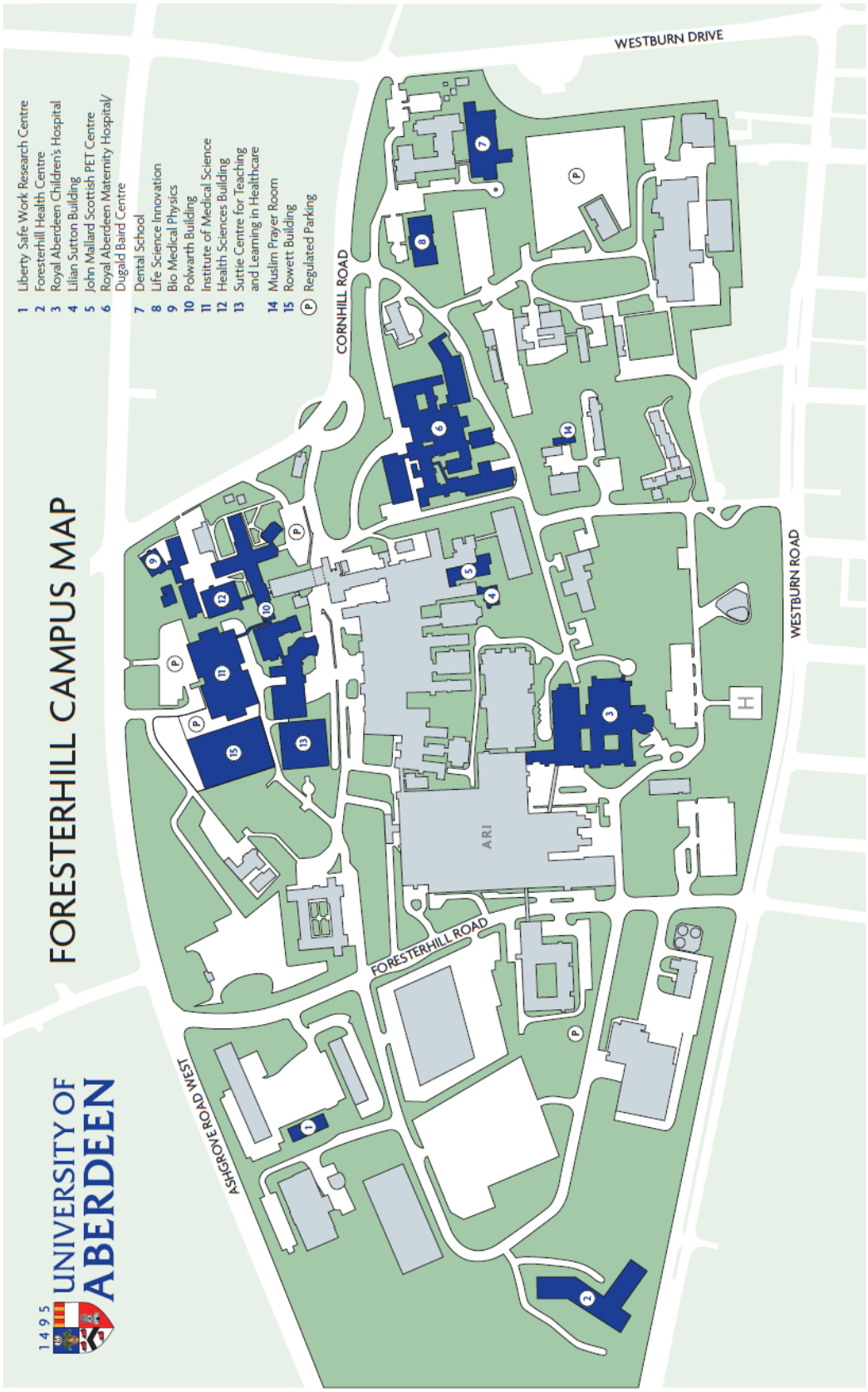
	14:00-15:00	MacRobert LT	Muscle 1	Lecture	GSB
Week 14					
Mon 30 Oct					
Tue 31 Oct	14:00-15:00	Arts Lecture Theatre	Muscle 2	Lecture	GSB
Wed 1 Nov					
Thu 2 Nov	14:00-15:00	FN1	Muscle 3	Lecture	GSB
Fri 3 Nov	17:00	Deadline for submission of SIMNERV Lab Report			
	14:00-15:00	MacRobert LT	Sensory Systems 1	Lecture	DS
Week 15					
Mon 6 Nov					
Tue 7 Nov	14:00-15:00	Arts Lecture Theatre	Sensory systems 2	Lecture	DS
Wed 8 Nov					
Thu 9 Nov	14:00-15:00	FN1	Sensory systems 3	Lecture	DS
Fri 10 Nov	10:00-13:00	STH 2.006/ 1.007/0.004	Mid-term exam	Assessment	CC
	14:00-15:00	MacRobert LT	Sensory systems 4	Lecture	DS
Week 16					
Mon 13 Nov					
Tue 14 Nov	14:00-15:00	Arts Lecture Theatre	Sensory systems 5	Lecture	DS
Wed 15 Nov					
Thu 16 Nov	14:00-15:00	FN1	Sensory systems 6	Lecture	DS
Fri 17 Nov	10:00-13:00	STH 1.001/ 1.007	Practical 3: Sensory Physiology	Practical	CC/IR/DS
	14:00-15:00	MacRobert LT	Blood & Defence 1	Lecture	AMJ
Week 17					
Mon 20 Nov					
Tue 21 Nov	14:00-15:00	Arts Lecture Theatre	Blood & Defence 2	Lecture	AMJ
Wed 22 Nov					
Thu 23 Nov	14:00-15:00	FN1	Blood & Defence 3	Lecture	IC
Fri 24 Nov	17.00	Deadline for submission of Sensory Physiology (Cockroach Leg) Lab Report			
	14:00-15:00	MacRobert LT	End of Course Information and FAQ	Lecture	CC
Fri 1 Dec	10:00-12:00	STH	Final exam	Assessment	CC

Staff

Dr Guy Bewick (GSB), Medical Sciences
Dr Isabel Crane (IC), Medical Sciences
Dr Catriona Cunningham (CC), Medical Sciences (Course Coordinator)
Dr Alison Jack (AMJ), Medical Sciences
Dr Pietro Marini (PM), Medical Sciences
Dr Iain Rowe (IR), Medical Sciences
Dr Derryck Shewan (DS), Medical Sciences
Prof Steve Tucker (SJT), Medical Sciences

Teaching Venues

Arts Lecture Theatre	William Guild Building (Ground Floor)
FN1	Fraser Noble Building Lecture Theatre 1
MacRobert LT	MacRobert Building Lecture Theatre (Ground Floor)
STH	Science Teaching Hub Labs



Floor Plans Polwarth

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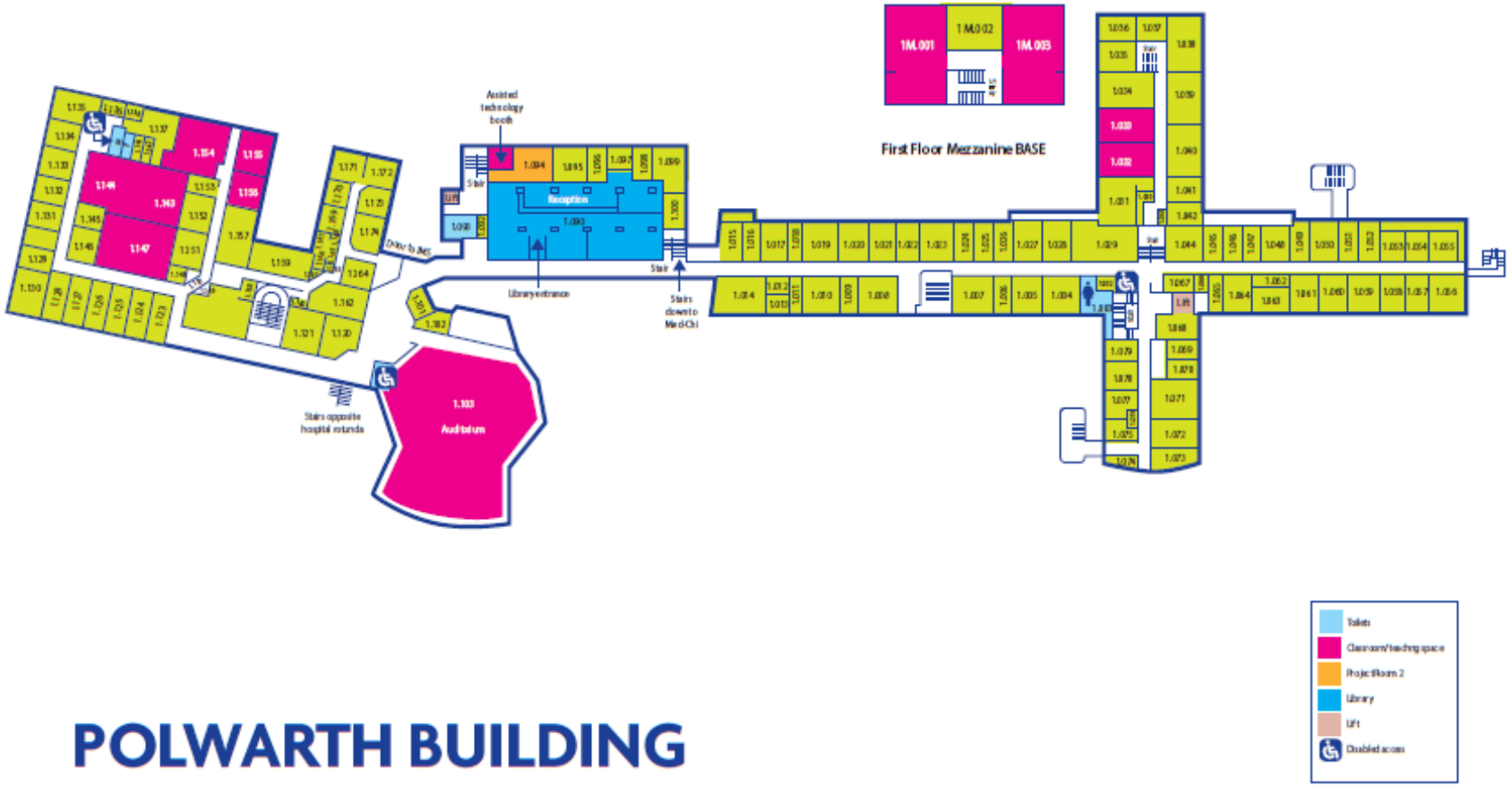

POLWARTH BUILDING

First floor

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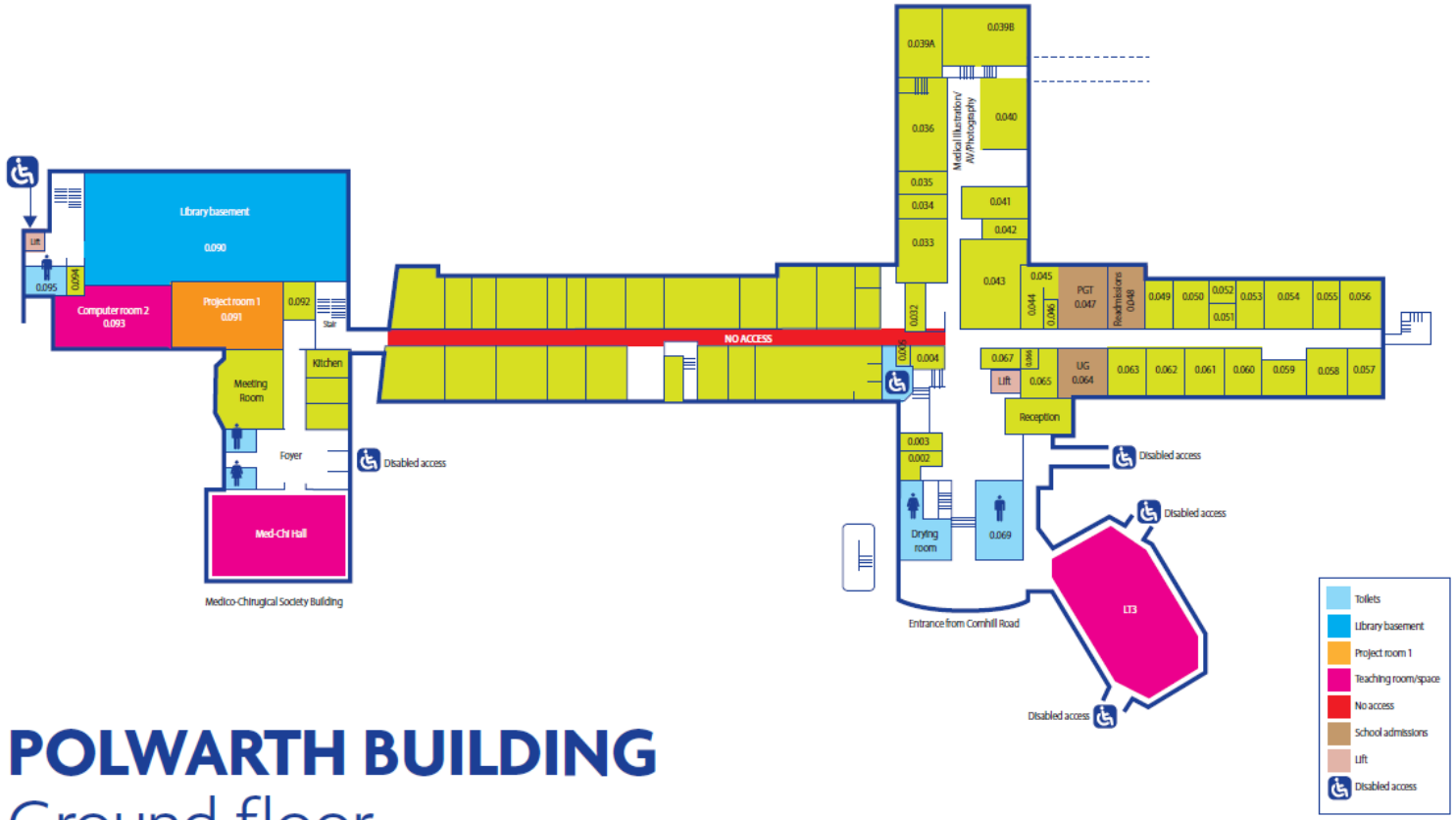

POLWARTH BUILDING
Ground floor

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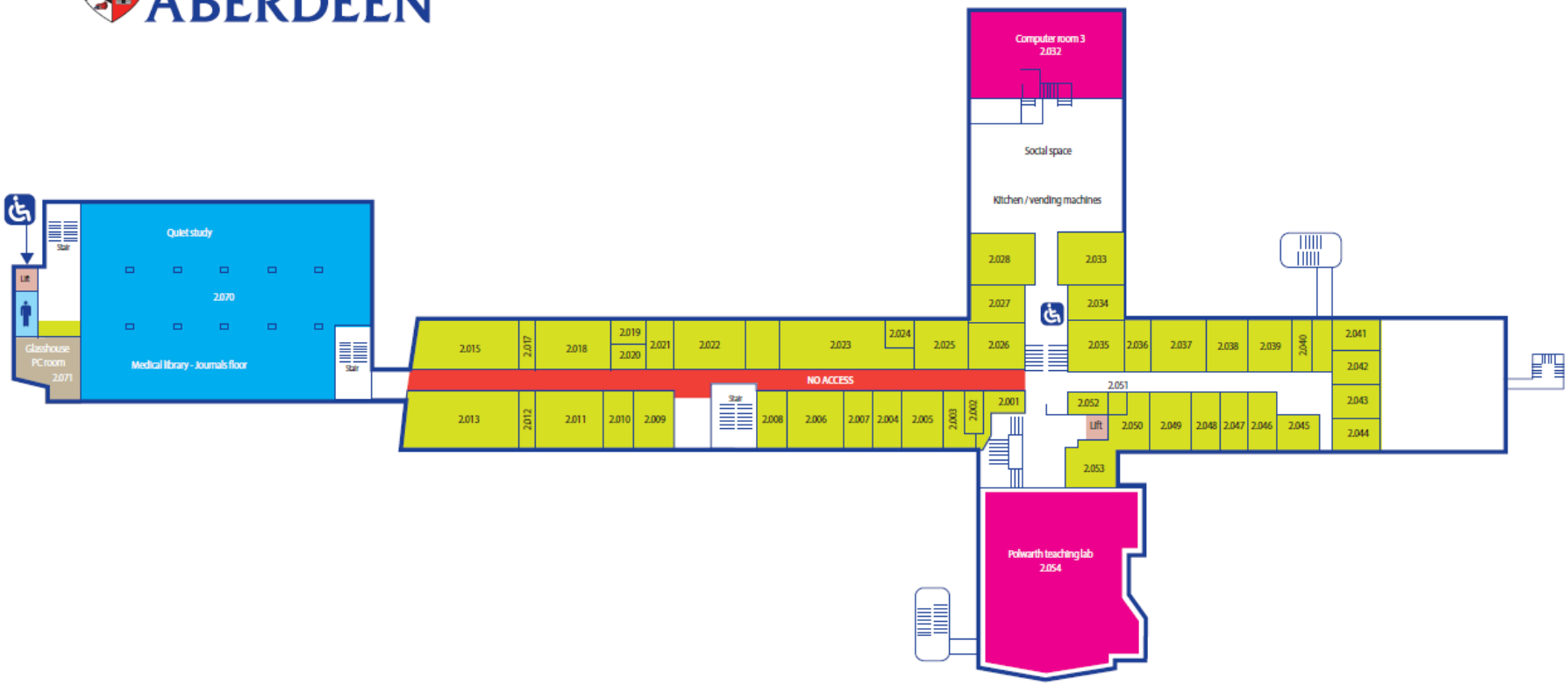

POLWARTH BUILDING
Second floor