PY3803

Epithelial Physiology

Course Handbook
2022-2023

School of Medicine, Medical Sciences & Nutrition

Contents

Course Summary

Epithelial transport is essential for the maintenance and propagation of life. In this course you will explore the features of transporting epithelial cells which make them uniquely suited for mediating the controlled, directional passage of ions, nutrients and water across the walls of the alimentary, renal, and respiratory systems. The importance of these processes to the normal physiological function of these organ systems is reflected by the pathophysiological symptoms which manifest themselves when transport regulation breaks down. For example, infectious diarrhoea occurs as a result of excessive intestinal fluid secretion and accounts for more than half a million child deaths per year in developing countries. At the other extreme, the most common genetic disease of the developed world, cystic fibrosis, is caused by a failure of epithelial tissues to secrete any fluid at all resulting in malnutrition, infertility and ultimately, respiratory failure and death. The course will initially examine the common features of transporting epithelial cells and the technologies available for their study. Following on from this, the role of epithelial cells in the kidney, gastrointestinal tract and respiratory system will be examined in detail. Emphasis is placed on understanding the cellular transport mechanisms required for the normal physiological function of these systems in health. Where insight into these processes has been enhanced by the study of disease models, these will be highlighted.

Course Aims & Learning Outcomes

1. To describe the general features of transporting epithelial cells.

2. To relate structure to function at molecular, cellular, tissue and organ system levels.

3. To describe the mechanisms underlying the regulated, directional transport of ions, nutrients and water across vertebrate epithelia.

4. To compare and contrast epithelial transport mechanisms which subserve normal physiological function of the renal, alimentary and respiratory systems and to appreciate the potential consequences of pathophysiological malfunction.

5. To gain an appreciation of the available technologies utilised for the study of epithelial transport processes and to provide experience of experimental methods for studying transepithelial ion and water transport.

Course Teaching Staff

Course Co-ordinator:
Prof Gordon McEwan (GTAM) (01224 437403) g.t.a.mcewan@abdn.ac.uk
Other Staff:
- Prof Derek Scott (DAS) (01224 437566) d.scott@abdn.ac.uk

Assessments & Examinations

There will be a 30% continuous assessment component to this module based upon the laboratory report (20%) and on the research paper presentation (10%).

There will be a written online assessment at the end of the course. It will consist of a choice of two questions selected from a total of four. The assessment paper will be in two sections (A and B), one question should be answered from each section. Each answer will contribute 35% to the total assessment for the course.

Students are expected to attend all lectures, participate in practical exercises and workshops, and to complete and submit all class exercises by the stated deadlines.

For those students who do not successfully complete the course, there will be a re-sit assessment in July.

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
- Convenor of the Medical Sciences Staff/Student Liaison Committee (Professor Gordon McEwan)
- Personal Tutor
- Medical Sciences Disabilities Co-ordinator (Dr Derryck Shewan)

All staff are based at Foresterhill and we strongly encourage the use of email or telephone the Medical Sciences Office. You may have a wasted journey travelling to Foresterhill only to find staff unavailable.

If a course has been completed and students are no longer on campus (i.e. work from second half session during the summer vacation), coursework will be kept until the end of Fresher's Week, during the new academic year. After that point, unclaimed student work will be securely destroyed.

Course Reading List

The general textbook listed below provides a lot of information relevant to this course. Where appropriate, you will also be directed to specific reading material for individual topics.

Boron, W.F & Boulpaep, E.L, Medical Physiology Third Edition, Elsevier Saunders (2016).

This is available as an ebook from the library via the following link:
https://ebookcentral.proquest.com/lib/abdn/reader.action?docID=5553767

The following chapters are relevant to the course. Coverage tends to go beyond the level of detail required. You should, therefore, be selective in your reading. There may also be further relevant material not covered in the listed chapters. You should use the index to identify such relevant information.

- Chapter 2: Functional organisation of the cell
- Chapter 5: Transport of solutes and water
- Chapter 35: Transport of sodium and chloride
- Chapter 39: Transport of acids and bases
- Chapter 42: Gastric Function
- Chapter 44: Intestinal fluid and electrolyte movement
- Chapter 45: Nutrient digestion and absorption

Lecture Synopsis

Lecture 1. Introduction to transporting epithelia – Prof Gordon McEwan

This lecture will provide an introduction to the course and will provide an appreciation of the relevance of studying epithelial transport within the context of contemporary biomedical research. The general features of transporting epithelia will be reviewed, and key aspects of the course will be sign-posted.

Lecture 2. Membrane trafficking and epithelial polarity – Prof Gordon McEwan

All transporting epithelia are polarised with a distinct apical and basolateral membrane. The maintenance of this polarity and the regulated sorting of transport proteins through the biosynthetic pathway to selected specific membrane domains will be considered. Finally, the strategy of regulated recruitment as a means of controlling epithelial transport mechanisms will be investigated.

Lecture 3. Epithelial tight junctions – Prof Gordon McEwan

The epithelial tight junctional complex serves two functions - (a) provision of a selective barrier to the paracellular transport pathway and (b) maintenance of epithelial polarity by restricting lateral diffusion of membrane proteins between apical and basolateral domains. The components of junctional complexes will be considered along with the properties which permit the junctions to fulfil their essential role in maintaining epithelial integrity.

Lecture 4. Renal sodium chloride transport – Prof Derek Scott

The segmental and spatial arrangement of the renal nephron is central to its action as the functional unit of the kidney. This lecture will examine how sodium and chloride transport mechanisms vary in different parts of the nephron and will pay particular attention to the way these segmental differences combine to give the kidney the capacity to maintain salt and water balance in the body.

Lecture 5. Acid/base transport – Prof Gordon McEwan

All cells require to regulate their intracellular pH. This lecture will consider the various acid/base transport mechanisms which have been identified in plasma membranes. As an example of how these transport

proteins contribute to epithelial transport processes, the mechanisms involved in acidification of urine at the levels of proximal and distal tubule will be considered in detail.

Lecture 6. Renal water transport – Prof Derek Scott

This lecture compliments lecture 5 by examining the various water channels present in the kidney nephron and discussing the ways they act in order to allow the kidney to maintain body water balance. It will also provide an up-to-date account of the molecular structure of these channels and their family relation to water channels found in other tissues of the body.

Lecture 7. Gastric acid secretion – Prof Gordon McEwan

During feeding, the epithelial lining of the stomach secretes hydrochloric acid. This results in the contents of the gastric lumen falling to below pH 2, sterilising ingested materials and initiating protein digestion. The mechanism adopted to overcome the 10-million-fold proton gradient required for the achievement of this process will be examined in detail. The range of factors involved in the regulation of gastric acid secretion will be considered. Finally, the relationship between gastric acid secretion, Helicobacter pylori and the formation of gastric ulcers will be explored.

Lecture 8. Intestinal sodium chloride transport – Prof Gordon McEwan

The small intestine is a heterogeneous structure consisting of villi and crypts. The epithelia covering these structures perform distinct tasks. The villus enterocytes are responsible for absorption of sodium chloride and water whereas the cells lining the crypt secrete sodium chloride and water. This creates a delicate, well-regulated balance between absorption and secretion. The cellular transport mechanisms adopted by villus and crypt cells will be investigated from both a physiological and pathophysiological viewpoint. The latter will involve brief consideration of the mechanisms underlying secretory diarrhoea and cystic fibrosis.

Lecture 9. Intestinal sugar transport – Prof Gordon McEwan

The bulk of ingested carbohydrate is transported across the small intestine in the form of glucose. It has been appreciated for almost forty years that glucose crosses the intestinal epithelium coupled to sodium, thereby contributing to transepithelial water absorption. Despite significant technological advances, the original description of the mechanism of intestinal glucose transport remains essentially unchanged. The historical background to our current understanding of the glucose absorption model will be considered. Finally, glucose transport will be contrasted with that of fructose.

Lecture 10. Intestinal amino acid transport – Prof Gordon McEwan

Amino acids are nutrients that must be effectively absorbed by the intestines. As a chemical class they are very varied with distinct properties derived from their different molecular structures. The body requires different proportions of amino acids at different times, and some amino acids may be synthesised de novo by the body whilst others are essential and can only be supplied from food intake. It is not surprising, therefore, that a wide range of transporters has evolved to cope with intestinal absorption of amino acids. The different classes of transporter found in intestinal tissue will be described and indication given as to how their properties can allow the intestines to provide the body with sufficient amino acids for its needs.

Lecture 11. Intestinal fatty acid transport – Prof Gordon McEwan

Fatty acids play a key role in body metabolism and hence form an important element of the diet. Their absorption from the gut is complicated by the fact that they are hydrophobic and lipophilic molecules and consequently they are handled by quite different mechanisms than those associated with hydrophilic nutrients such as glucose and amino acids. This lecture will review the mechanisms associated with fatty acid absorption paying particular attention to essential fatty acids and their important long chain polyunsaturated derivatives such as arachidonic acid.

Lecture 12. Epithelial transport of essential metals – Prof Derek Scott

Essential metal ions (e.g. iron, zinc, copper, etc.) play a fundamental role in many biological processes, such as signalling, homeostasis and catalysis. However, while deficiency in any of these metals can be highly detrimental to health, they are also highly toxic to cells and their transport must be tightly controlled. This lecture will consider the problems associated with the transport of metal ions and will review the mechanisms associated with metal transport across mammalian small intestine.

Lecture 13. Role of epithelium in respiration – Prof Gordon McEwan

The structure of the various epithelial cell types which line the airways will be described in relation to their specific functions within the respiratory system. Consideration will be given to the role of respiratory epithelia in airway disease.

Practical/Lab/Tutorial Work

Research Seminar
The intestinal acid microclimate – Professor Gordon McEwan
This research seminar will explore the research background to the discovery and acceptance of proton-coupled nutrient transport in mammalian small intestine.

Practical Work
The course contains a practical exercise which is delivered through the AD Instruments Lt platform. This exercise investigates the transport of sodium across the isolated frog skin. Following completion of the exercise, you will each prepare an individual report which should be word processed in the form of a short

scientific paper. Everything you require to complete the exercise will be presented within a customised Lt learning package.

Students with special educational needs
In the event that any work required in this course presents difficulties to students with special educational needs, alternative arrangements will be made. Any student with special needs should make these known to the Course Co-ordinator when registering for the class and should then also discuss their needs with the School Disabilities Co-ordinator, to ensure that they have the best possible outcome.

Research Paper Presentations
Groups of three students will be allocated a short scientific paper related to epithelial physiology. Each group of students will be required to present their paper using MS PowerPoint presentation software. Each presentation will be of ten minutes duration and will be followed by a five-minute discussion period. Papers will be selected at random and instruction will be provided on the basic construction of a PowerPoint presentation for the presentation of a scientific communication. Individual presentations will be assessed for delivery and content and this will contribute towards the final course assessment (10%).

Each presentation should:

• Set the background to the work described in the paper
• Identify the aims of the paper
• Outline the methodological approach adopted
• Describe the main results presented
• Discuss the physiological relevance of the main results
• Assess whether the aims of the paper have been achieved

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 2022/23 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 2022-23 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

More information and how to book a place can be found here

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			

PY3803 Course Timetable: 2022-2023

Date	Time	Place	Subject	Session	Staff
Week 31					
Mon 27 Feb	14:00-15:00	MR310	Lecture 1: Introduction to transporting epithelia	Lecture	GTAM
Tue 28 Feb	09:00-12:00	STH 0.004	Selection of seminar papers and workshop on preparing a PowerPoint presentation	Workshop	GTAM
Wed 1 Mar	09:00-10:00	MR310	Lecture 2: Membrane trafficking and epithelial polarity	Lecture	GTAM
Thu 2 Mar					
Fri 3 Mar	14:00-17:00	STH 0.004	Data analysis and presentation	Workshop	GTAM
Week 32					
Mon 6 Mar	14:00-16:00	MR310	Lecture 3: Epithelial tight junctions	Lecture	GTAM
Tue 7 Mar	10:00-13:00	STH 0.004	Practical: Sodium transport across the frog skin	Practical	GTAM
Wed 8 Mar	09:00-10:00	MR310	Lecture 4: Renal sodium chloride transport	Lecture	DAS
Thu 9 Mar					
Fri 10 Mar	14:00-15:00	MR310	Lecture 5: Acid-base transport	Lecture	GTAM
Week 33					
Mon 13 Mar	14:00-15:00	MR310	Lecture 6: Renal water transport	Lecture	DAS
Tue 14 Mar			Preparation of frog skin transport practical reports		
Wed 15 Mar	09:00-10:00	MR310	Lecture 7: Gastric acid secretion	Lecture	GTAM
Thu 16 Mar					
Fri 17 Mar	14:00- 15:00	MR310	Lecture 8: Intestinal sodium chloride transport	Lecture	GTAM
	18:00		**Submit frog skin practical report**		
Week 34					
Mon 20 Mar	14:00-15:00	MR310	Lecture 9: Intestinal sugar transport	Lecture	GTAM
Tue 21 Mar	09:00-17:00		Preparation of PowerPoint seminar presentations		
Wed 22 Mar	09:00- 10:00	MR310	Lecture 10: Intestinal amino acid transport	Lecture	GTAM
Thu 23 Mar					
Fri 24 Mar	14:00-15:00	MR310	Lecture 11: Intestinal fatty acid transport	Lecture	GTAM
	18:00		**Submit PowerPoint presentation**		
Week 35					
Mon 27 Mar	14:00-16:00	MR310	Research Seminar: The intestinal acid microclimate	Lecture	GTAM
Tue 28 Mar	09:00-17:00	STH 0.001	PowerPoint seminar presentations	Presentation	GTAM
Wed 29 Mar	09:00-10:00	MR310	Lecture 12: Epithelial transport of essential metals	Lecture	DAS
Thu 30 Mar					
Fri 31 Mar	14:00-15:00	MR310	Lecture 13: Role of epithelium in respiration	Lecture	GTAM

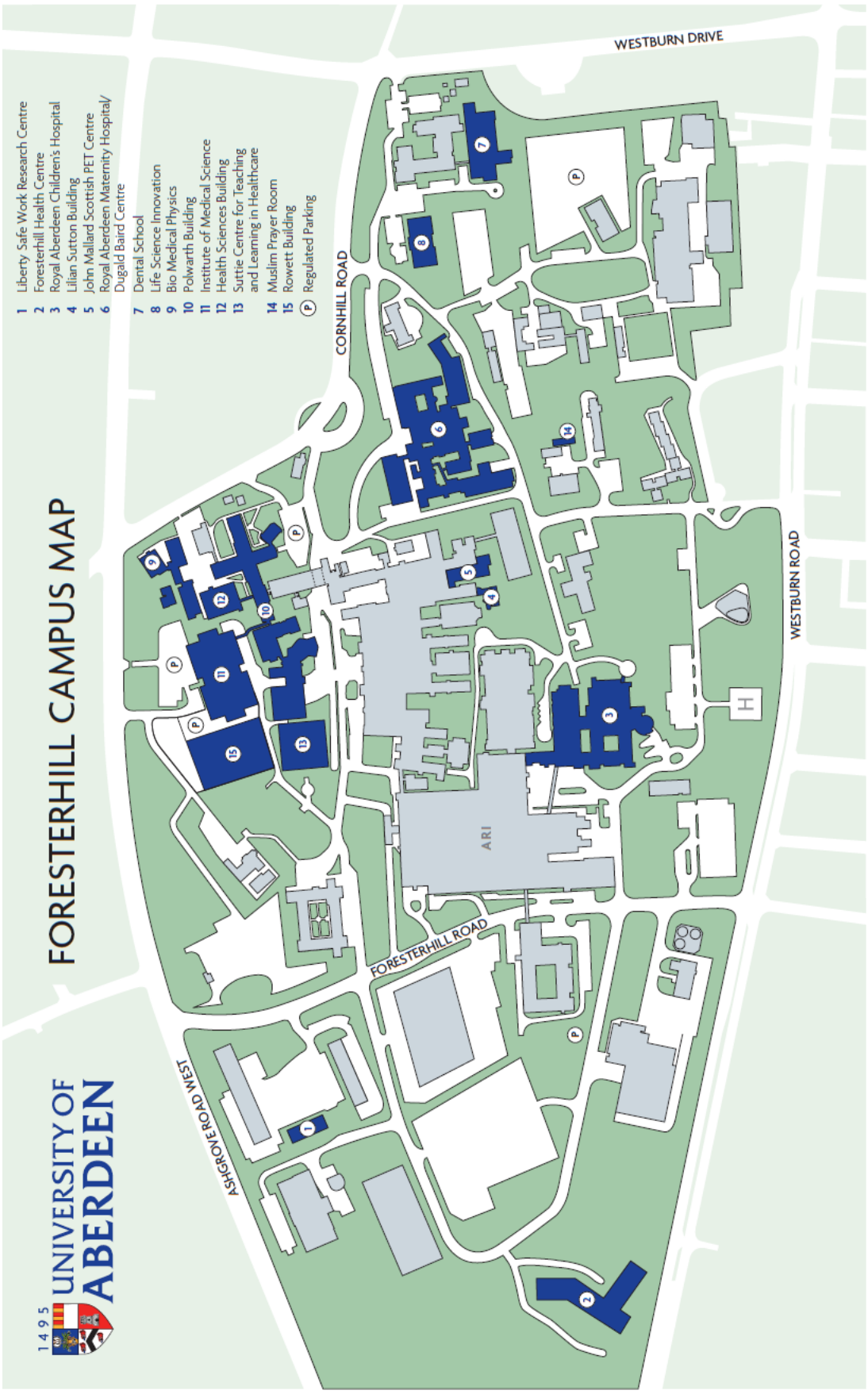
Staff

- Prof Gordon McEwan (GTAM), Course Co-ordinator
- Prof Derek Scott (DAS)

Venues

MR310: MacRobert Building Room 310
STH: Science Teaching Hub

Campus Maps - Foresterhill



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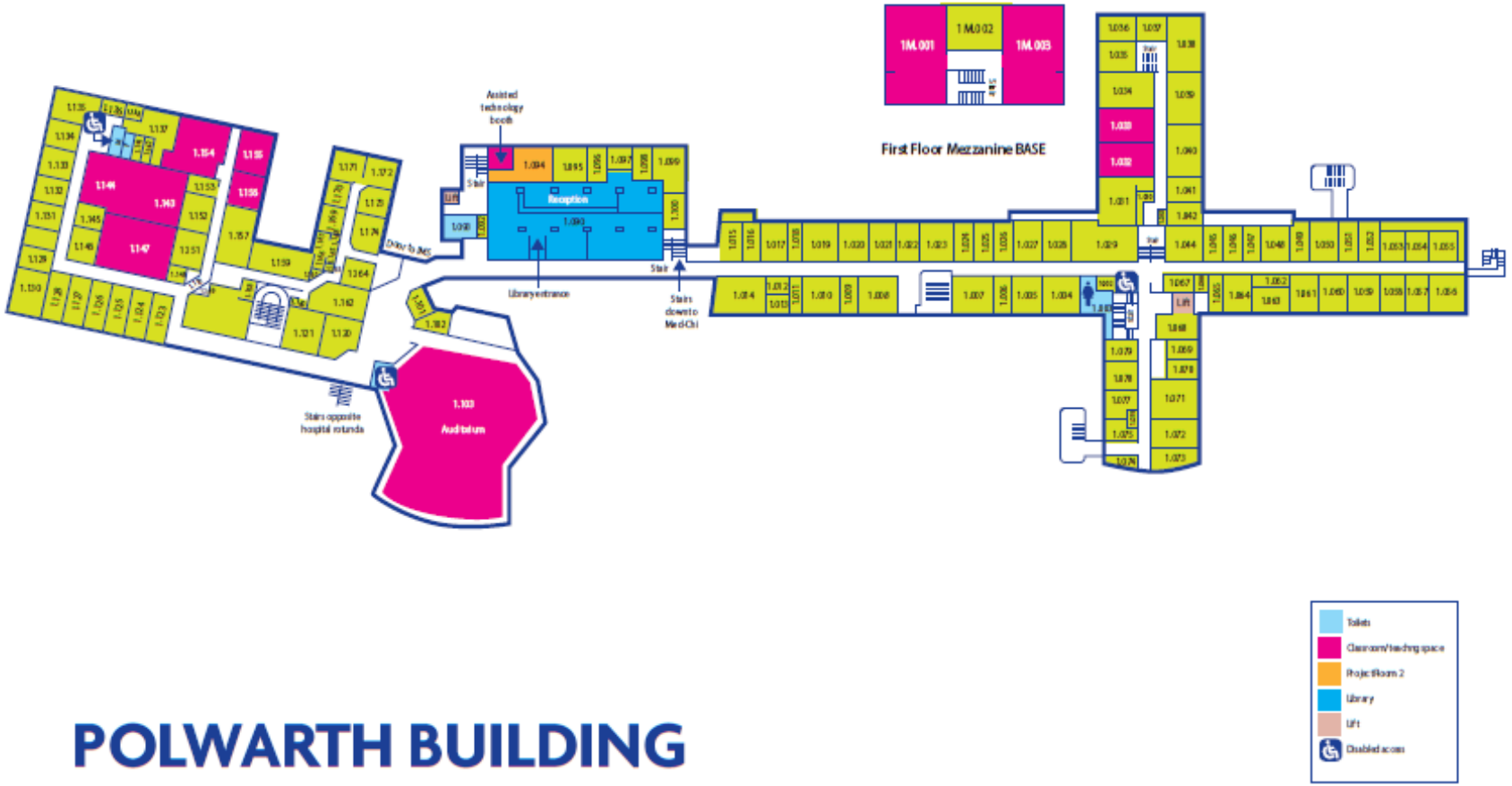

POLWARTH BUILDING

First floor

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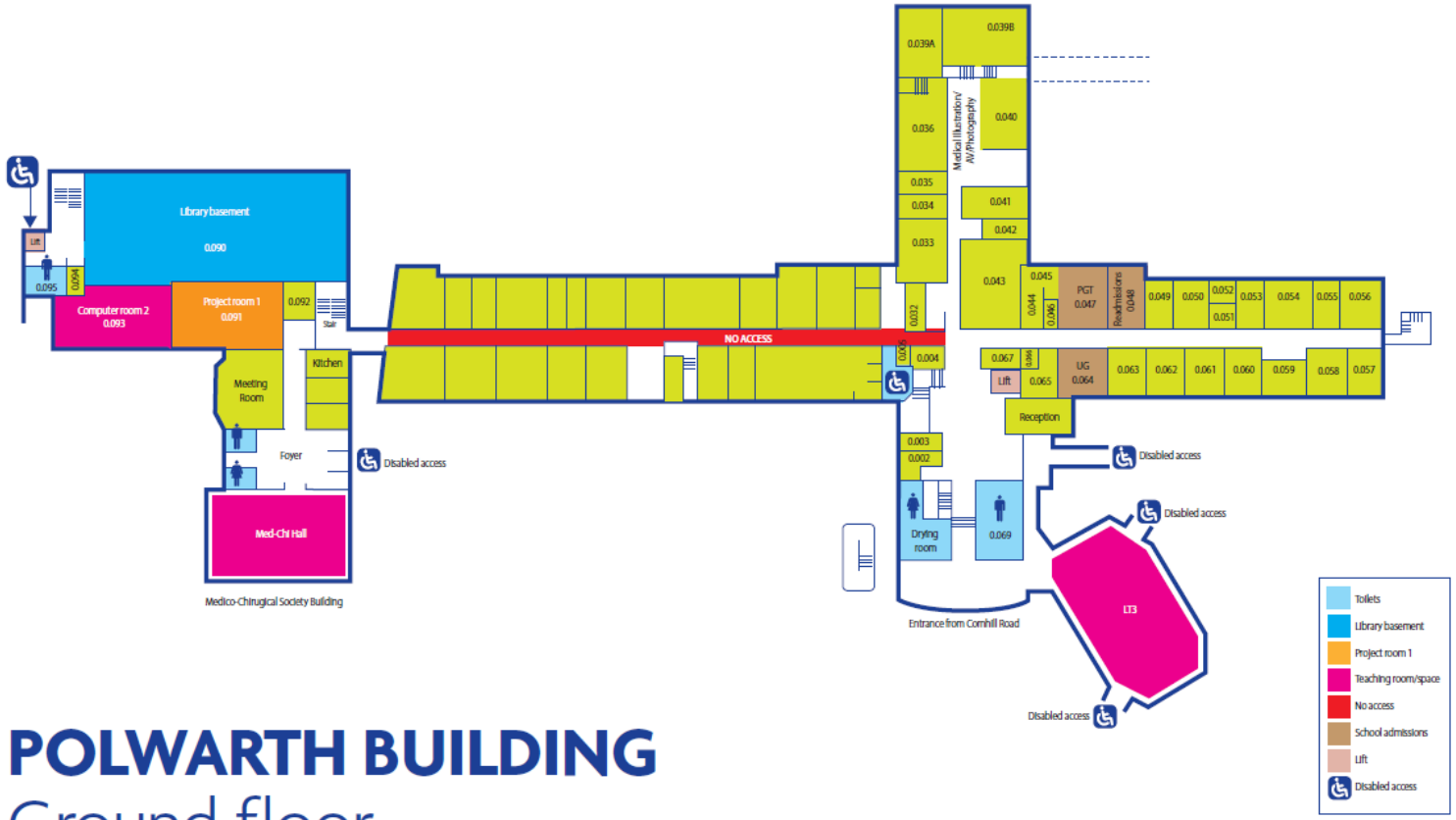

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Ground floor

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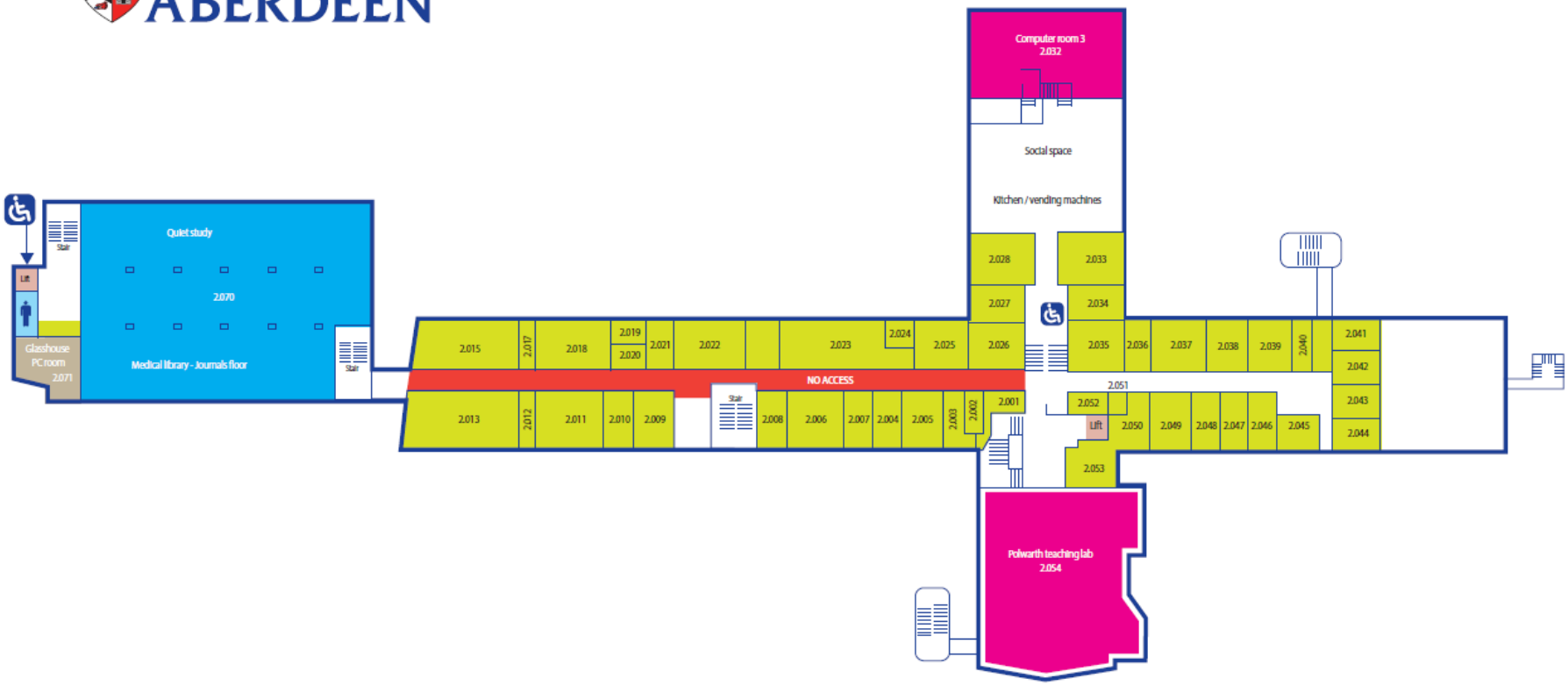

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Second floor