Faculty of Science Course Syllabus
Department of Biology
BIOL 3050: Developmental Biology
Fall 2021

Instructor(s): Margaret Cooper Margaret.Cooper@dal.ca (902) 494-8436 LSC 4014

- I do not have set office hours but am available to meet with you throughout the week by appointment. My preference will be to meet via Teams but I will be happy to meet in-person if you prefer.

Lectures:

- Most lecture material will be available online for you to view asynchronously.
- We will have at least one synchronous lecture session per week. The specific dates of synchronous sessions are detailed in the lecture schedule.
- The time and location of synchronous lectures will be: 1:35-2:25 MWF, LSC P5260 (or in our Brightspace Collaborate when necessary).
- The slides from in-person lectures and recordings of online synchronous sessions will be posted online.

Laboratories:

- Nine three-hour lab sessions in LSC 4016
- Laboratories will be in-person except during the week of September 27th. Online asynchronous activities will be used the week of September 27th. When labs are in-person, a lab coat and non-medical mask are required PPE.
- Online asynchronous activities will also be used when necessary due to public health restrictions.

Mask Policy:

- Masks must be worn during all in-person learning activities as well as in-person meetings through September. Dalhousie's mask policy will be updated again after September 30th. As someone with an unvaccinated child at home and in recognition of the many others in comparable circumstances, I will ask and encourage everyone to continue wearing masks throughout the term.

Course Description

Lectures describe development as a sequence of processes and events, in which 'simple' structures such as fertilized eggs are progressively transformed into complex organisms. These events are governed by developmental 'rules' which have been determined through experimental study of animal and plant model organisms. Laboratories use live material whenever possible.

Course Prerequisites

BIOL 2020 and BIOL 2030

Course Objectives/Learning Outcomes

- Identify a few major researchers in the development of the field of Developmental Biology and outline how our understanding of embryonic development has changed over time.
- Know the characteristics of the major experimental model organisms
- Identify and define the major stages in the development of model organisms
- Demonstrate an understanding of selected molecular techniques used in the field of Developmental Biology
- Demonstrate an understanding of the process of gamete production and fertilization
- Understand the steps involved in cleavage and gastrulation and also identify the types of cell movements involved in gastrulation
- Distinguish between germ layers and list what tissues/organs develop from each germ layer
- Describe mechanisms by which embryonic cells communicate and explain their role in regulating embryonic development
- Describe the mechanisms of gene expression regulation and explain their importance in controlling developmental processes
- Outline the processes involved in generating a nervous system
- Outline the process involved in limb development
- Identify and differentiate between mechanisms used to develop a complex, multicellular organism.
- Outline the differences and similarities between plant and animal development and demonstrate an understanding for the basis for these differences
- Demonstrate an understanding of the process of pollination and fertilization
- Describe the structure of apical meristems and their role in development
- Demonstrate an understanding of the principal mechanisms that regulate leaf, flower and root development
- Explain the significance of hormones in plant development and describe the role of each of the five major hormones in development
- Identify embryonic structures in slide preparations, photographs and diagrams
- Relate the appearance of two-dimensional microscope sections to three-dimensional embryos
- Carry out simple experiments using selected model species
- Write a formal laboratory report

Course Materials

Although there is not a REQUIRED text assigned to the class, we strongly recommend that you purchase the text, ***Principles of Development*, 6th*. Ed., 2019; by Wolpert et al***. It is particularly helpful for the Animal Development section and has a good chapter on Plant Development. Figures in the text will be referred to during lectures and specific sections of the text will also be assigned as recommended

readings. This year an electronic version of the textbook can be purchased through the Dalhousie Bookstore and accessed via the class Brightspace page. The 4th and 5th editions of the text can also be used, however, electronic versions are not available and you will be responsible or determining the appropriate sections and pages to read.

We also recommend that you consider purchasing the text ***A Student Handbook for Writing in Biology; 5th ed., 2017 by Karin Knisely.*** This text is relatively inexpensive and is a very good reference text to consult when writing your laboratory reports.

There is no printed lab manual for this course. Your labs will be posted on Brightspace throughout the term. This will allow flexibility in how you can view the lab information during your lab session. If you have a tablet or small laptop that you normally carry with you, you can view the introductory portion of the lab electronically during lab and only print the Lab Exercises that you will hand in at the end of lab. If you prefer to have a hard copy with you in lab, simply print the entire lab. I should warn everyone though that WiFi in the Life Sciences Centre is notoriously poor. So, if you plan to view an electronic copy of the lab during your lab session, make sure it is downloaded to your device prior to coming to lab. **It is mandatory that every student has the lab information with them in some form during their lab sessions and that everyone has a printed copy of the Lab Exercises**.

Course Assessment

Component	Weight (% of final grade)	Date
<u>Lecture</u>		
Exam I	10 %	October 4th
Lightning Talk	8 %	October 13th or 15th
Organogenesis Article Analysis	4 %	October 28th
Exam II	16 %	November 1st
Flower Assignment	4 %	November 24th
Exam III	18 %	TBD
<u>Lab</u>		
Pre-Lab Quizzes/Lab Assignments	25 %	Throughout term
Lab Report	15 %	Week of November 15h

Conversion of numerical grades to Final Letter Grades follows the <u>Dalhousie Common Grade Scale</u>

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (<50)
A- (80-84)	B- (70-72)	C- (55-59)	

Return to In-Person Learning

We are coming out of a very unusual year. This may be the first time since first-year that you find yourself in a class laboratory setting. You are likely still developing many of the hands-on laboratory skills, as well as time-management skills, that students normally master in second year. Your TAs and I recognize that there may be a steep learning curve for many of you this year, and we will do our best to provide all the help and instruction you need.

Course Policies

To avoid any misunderstanding or confusion during the term, please note the following policies. These regulations have been put in place to try to ensure fair and equal treatment for all. Extenuating circumstances can arise however, so please feel free to see Dr. Cooper if you have problems with any of these regulations at any time during the term.

Running of Labs:

a) Labs will start promptly at 2:35 with a pre-lab overview of the material you will be studying and clarification of any instructions if necessary. You will each work at your own pace and can feel free to leave or take a break whenever you wish, but the lab will be closed at 5:25 and at that time, everyone will be expected to submit their assignments for evaluation and will be asked to leave.

b) You will select a bench position where you will be expected to sit for the entire term. You are each responsible for the proper use, maintenance and storage of the microscopes located in the cupboard in front of your position. Before leaving the lab, put away all equipment, tidy up your work area and wash and dry all dirty glassware as instructed.

c) Pairs of students will be assigned slide boxes containing all the prepared slides for the term. You will be expected to check that all the slides are in your box before you start each lab, and to likewise ensure that all slides are in their proper slots when you leave.

d) We will be using live animals in two of the lab sessions (i.e. sea urchins to study fertilization and early development and planaria to study regeneration).

Illness and Extensions:

There will be times during your term when you will have deadlines in several different courses at the same time. **PLAN AHEAD. WORK CONSISTENTLY.** Your time at University should, among other things, teach you to develop effective time management skills and study habits. On the other hand, unforeseen events such as personal/family crisis, or illness can occur during the term. This is likely to be particularly true for the coming term. These occurrences are unavoidable and the staff of BIOL 3050 will be most understanding. Special arrangements for examinations and assignments in the event of illness or other

exceptional circumstances will be made at the discretion of the teaching staff. Alternate arrangements will be considered provided that:

- a student who misses class work (i.e. exam, deadline for submission of an assignment, etc.) because of illness **NOTIFIES THE INSTRUCTOR ON THE DAY IN QUESTION**, and submits a Student Declaration of Absence (SDA). A maximum of two SDA may be used in this course throughout the term.

- a student who, for medical reasons (e.g., scheduled day surgery, physiotherapy etc.), anticipates missing class work notifies the instructor at least one week in advance;

- a student who misses class work due to other exceptional circumstances **NOTIFIES THE INSTRUCTOR ON OR BEFORE THE DAY IN QUESTION**, and is willing to produce appropriate documentation upon request.

Late Assignments:

Any material submitted for evaluation after the designated deadline, where an extension has not been granted, will have marks **DEDUCTED AT THE RATE OF 5% PER DAY LATE.** Assignments can be submitted up to the point when feedback has been provided to the rest of the class.

Plagiarism and Academic Integrity:

You are expected to abide by Dalhousie University's policies on academic integrity. There will be times in lab when you work as a group, but **every lab assignment that you submit must be independent and entirely your own wording**. The lab reports submitted for this class will be assessed using Urkund plagiarism software. You will do formal group work for the lecture-based assignments "Germ Layer Specification Presentation" and "Flower Development". ***These are the only two assignments for which you will make a group submission.***

Grade Changes:

We do not encourage requests for considerations of grade changes with the weekly submissions from the laboratory sessions. These small assignments are graded by the teaching assistants using an marking key provided by the Instructor. While every effort has been made to ensure that the assessments are fair and as objective as possible, some individual variation in evaluations is inevitable. However, each week's material is worth only a few marks towards your total grades so any minor variations would be insignificant. Overall, prolonged discussions over fractions of points takes time away from the current week's activities and can create an unhealthy, confrontational atmosphere. **ON THE OTHER HAND**, we **DO ENCOURAGE** discussion about "where you went wrong" so that you will not make the same mistakes the next time and you will learn and improve. In all cases, the procedure is to approach the person who graded your material and to do so as soon as possible after receiving the evaluation. **THERE WILL BE NO CONSIDERATIONS OF GRADE CHANGES FOR LAB ASSIGNMENTS**

BEYOND 1 WEEK AFTER YOUR ASSIGNMENT IS RETURNED (i.e., do not bring assignments for re-evaluation at the end of term!). In regards to exams given during the lecture portion, requests for grade reassessment must be done in writing. The written request must be made within one week of the date the exam was returned.

Tentative Lecture and Laboratory Schedule

Week	Synchronous Lecture Date	Online Asynchronous Lecture Video Content	Labs
Sept 6-10	Wednesday Sept 8	Introduction to Developmental Biology	
		Basic Concepts of Developmental Biology	
		Model Organisms	
Sept 13-17		Development of Germ Cells	Gametogenesis
		Gametogenesis and Fertilization	**Pre-lab Quiz: 0.5%**
	Friday Sept 17	Preventing Polyspermy & Imprinting and Parthenogenesis	**In-lab Assignment: 2%**
Sept 20-24		Overview of early development	Fertilization and Cleavage
		Cleavage	**Pre-lab Quiz: 0.5%**
	Friday Sept 24	Morphogenesis	**In-lab Assignment: 4.5%**
Sept 27-Oct 1		Setting up the Body Axes	**ONLINE**: Gastrulation and
		Cell Specification and Determination	Neurulation
	Friday Oct 1	Exam Review	**Assignment: 5%**
Oct 4-8	**Oct 4 - Exam 1: Through Morphogenesis**	Cell Differentiation	Planaria Regeneration I
	(10%)		**In-lab Assignment: 0.5%**
	Wednesday Oct 6	Specification and Patterning of the Germ Layers	
Oct 11-15	**Germ Layer Specification Presentations**		Planaria Regeneration II
	(8%) Oct 13 or 15	Neural Induction and Patterning	
Oct 18-22		Organogenesis (Limb and Eye Development)	Planarian Regeneration III
		Wednesday Oct 27 - Organogenesis Article Analysis Due	**Assignment (4.5%)**
	Friday Oct 22	**(4%)**	
Oct 25-29		Arabidopsis as a Model Species	Embryogenesis in Angiosperms
		Phytohormones	**Pre-lab Quiz: 0.5%**
	Friday Oct 29	Exam Review	**In-lab Assignment: 2%**
Nov 1-5	**Nov 1 - Exam 2: Setting up Body Axes**	Establishing the Body Plan	Early Seedling Development
	through Organogenesis (16%)		
	Friday Nov 5		
Nov 8-12			Reading Break
Nov 15-19		Meristems in the Shoot and Root	**No Lab - Lab Report Due (15%)**
	Friday Nov 19		
Nov 22-26		Leaf Development	Root System Development I
		Wednesday Nov 24 - Flower Development Assignment	**Pre-lab Quiz: 0.5%**
	Friday Nov 26	**Due (4%)**	
Nov 29-Dec 3		Trichome Production	Root System Development II
		Root Hair Patterning	**In-lab Assignment: 4.5%**
	Friday Dec 3	Stomatal Development	
Dec 6&7	Monday Dec 6	Exam Review	
	Exam 3 - Plant Section (18%) - Date TBD		

Course Content - *Tentative Lecture Topic Outline*

PART I – Animal Development

Introduction to animal developmental biology
Goals and outline of the course
What is developmental biology?
Model organisms
Overview and comparison of early development in vertebrates (Xenopus)

Origin and approaches to animal developmental biology
Origins of developmental biology (early theories)
Anatomical approaches
Experimental approaches
Genetic approaches

Germ cells, gametogenesis and fertilization
Specification of germ cells
Oogenesis and spermatogenesis
Fertilization and prevention of polyspermy
Parthenogenesis

Cleavage: mechanisms, patterns and consequences
Cleavage cycle
Patterns and type of cleavage
Formation of the blastula

Morphogenesis
Cell shape, adhesion and movements
Morphogenic processes in gastrulation and neurulation
Molecular basis of gastrulation and neurulation

Axis formation: setting up the body axis
Dorsoventral and anteroposterior axis formation
Establishing left-right asymmetry

Cell specification and determination
Progressive determination of cell fate
Cell-cell communication
Acquisition of commitment
Eye development as an example of induction in development

Germ layer origin and specification
Mesoderm induction
Mesoderm patterning along the dorso-ventral and antero-posterior axes
Ectoderm and endoderm specification (Xenopus)

Antero-posterior patterning and somites; Neural tube induction
Somite specification and formation
Role of Hox genes in A-P patterning
Neural tube induction

Neural crest cells; cell differentiation
Neural crest cells origin, migration and patterning
Differential gene expression
Models of cell differentiation
Plasticity of gene expression

Limb development
Limb bud induction and formation
Development along the proximal-distal axis
Development in the dorsal ventral-axis
Digit specification and separation

PART II – Plant Development

Embryogenesis, seed development and germination
Stages in embryo development
Seed structure
Endosperm development
Germination

Introduction to phytohormones
What are phytohormones?
How hormones work –roles in development

Establishing the body plan: apical-basal and radial patterning
Embryo fate map
Specification of cell fate along the apical-basal axis
Hormones in apical-basal patterning
Radial pattern formation

Meristems
Types of meristems
Shoot apical meristems organization and maintenance
Root apical meristem, structure, specification and maintenance
Hormonal regulation of apical meristem activity

Development of lateral organs
Auxillary meristems and shoot branching
Positioning of lateral organs on the shoot apical meristem

Axis formation in leaves
Leaf morphology
Initiation of leaf development

Genetic control of leaf identity and complexity
Establishing leaf polarity and patterning

Flower development
Floral meristems
How to make a flower
Establishing floral meristem identity and determinacy
Determining floral organ identity: The ABC model

Patterning the epidermis (stomata, trichome and root hair)
Stomata structure and function
Guard cell fate specification and patterning
Trichome structure and function
Trichome fate specification and patterning
Root hair structure and function
Root hair fate specification and patterning
