DALHOUSIE UNIVERSITY

Faculty of Science Course Syllabus Fall 2020 (revised June 2020)

Department of Biology

BIOL 3050 (online)
Developmental Biology
Fall 2020

Instructor(s): Dr. Sophia Stone s.stone@dal.ca Office Hours: TBA

Dr. Margaret Cooper mhcooper@dal.ca Office Hours: TBA

Lectures and Labs:

- Synchronous sessions will be held, through Collaborate on our Brightspace site, on **Mondays** and **Wednesdays** from **1:35-2:25 ADT**. Additional synchronous meeting times will be arranged once the term begins. Attendance is not mandatory. All course components can be completed asynchronously.

COURSE DESCRIPTION

The course describes 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.

COURSE PREREQUISITES

BIOL 2020 and BIOL 2030

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 their role in regulating embryonic development

- Describe the mechanism 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
- 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 micrographs, photographs, and diagrams
- Relate the appearance of two-dimensional microscope sections to three-dimensional embryos
- Analyze simple experiments using selected model species
- Write a formal scientific report

COURSE MATERIALS

Lectures, readings, assignments, and quizzes will all be on our Brightspace site. Synchronous sessions will be held through Collaborate in our Brightspace site. We will also be using the Discussion boards and posting important announcements. It will be important for you to monitor these regularly.

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. Dr. Stone will be referring to figures in the text 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. 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.

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COURSE DESCRIPTION AND FORMAT

The course explores 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.

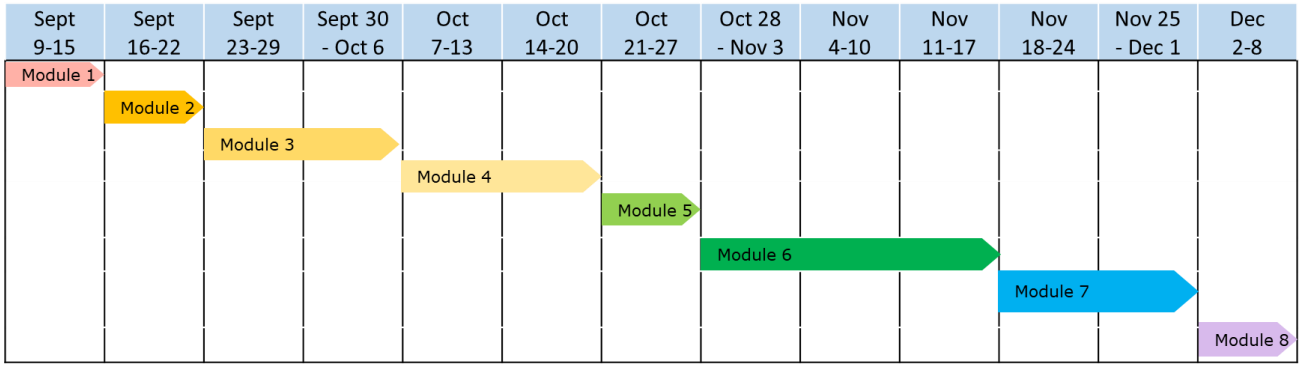
The course is organized into eight modules, each composed of video-conferencing sessions, lecture videos, instructional text, readings (textbook and relevant journal articles), and discussion questions. Modules will be one or two weeks in length. However, once module materials are posted on the course website they will remain accessible for the duration of the course. See the `course schedule` for a description of topics covered in each module.

The course is a blend of asynchronous and synchronous delivery of content. Materials for each module (lecture videos, instructional texts, etc.) including assessments (quiz, written assignments, presentation, etc.) will be made available on the course website at specific dates. The posted material may be consumed at your own pace (asynchronous), however assessments for each module must be submitted by the indicated time and date. During each module, we will have multiple video-conferencing sessions at set dates and times (synchronous) to discuss topics and review the material.

What is asynchronous and synchronous teaching (course delivery)?
Synchronous teaching - a learning environment in which instructors and students come together at the same time, often through a video-conferencing tool.
Asynchronous teaching - a learning environment created by instructors in which students have the flexibility to learn at a time convenient to them.

COURSE SCHEDULE

Animal development will be covered in Modules 1 to 5 and plant development will be explored in Modules 6 to 8. *The course schedule is subject to change.* You will be informed via email and all changes and updates will be posted on the course website.



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Module 1 - Introduction to Developmental Biology
One week: September 9 to September 15
Readings: Text pages 1-24, 94-98, 115-130, 674-679

The module will give an introduction to the instructors and also provide an opportunity for you to introduce yourself to everyone in the course. Topics covered will give an overview of developmental biology, illustrate some of the key questions in field and provide information on the main organisms used to study development.

Topics covered:
Introduction to developmental biology
Basic concepts in developmental biology
Model organisms

Module 2 - Gametogenesis and Fertilization in Animals
One week: September 16 to September 22
Readings: Text pages 4-6 (Section 1.2), 397-418

Animal embryos develop from a zygote, which is produced from the fusion of gametes, egg and sperm (fertilization). This module will explore how the developing embryo sets aside the germline cells, how those cells then develop into male or female gametes, and the events involved in fertilization in select vertebrates and invertebrates.

Topics covered:
Development of germ cells
Meiosis (review)
Gametogenesis and fertilization
Preventing polyspermy
Imprinting and parthenogenesis

Module 3 - Changes in the Early Animal Embryo
Two weeks: September 23 to October 6
Readings: Text pages 94-115, 142-150, 165-168, 183-195, 227-230, 254-260, 271-315, 320-323

This module will explore the early stages (cleavage, gastrulation and neurulation) of animal embryo development. During early development the embryo undergoes dramatic changes in form, which are achieved through changes in the adhesiveness of cells to one another, changes in cell shape and the ability of cells to move from one location to another. Major events in the `generation of form` or morphogenesis include gastrulation and neurulation.

Topics covered:
Cleavage
Gastrulation and Neurulation

Morphogenesis: cell adhesion, shape, and migration
Setting up the body axis

Module 4 - Specification and Patterning in Animal Embryos
Two weeks: October 7 to October 20
Readings: Text pages 6-8, 22-35, 150-171, 195-221, 333-353, 376-382, 505-518

As development proceeds, the organization of the embryo becomes increasingly complex and different cell types (e.g. skin cells and muscle cells) are formed. This module will explore how the embryo first becomes divided into broad regions, such as the three germ layers (ectoderm, mesoderm and endoderm), and how cells within these regions gradually become different.

Topics covered:
Cell specification and determination
Specification and patterning of germ layers
Neural induction and patterning
Cell differentiation and plasticity

Module 5 - Organogenesis and Regeneration in Animals
One week: October 21 to October 27
Readings: Text pages 435-436, 452-480, 577-591

The development of organs such as the heart, limbs, wings and teeth, begins after the body plan is laid down. This module will delve into the process of organ formation, focusing on the development of the eye and limb in mouse and chick. Regeneration, the ability of organisms to repair and replace damaged or lost parts will also be explored.

Topics covered:
Organogenesis (Limb and Eye Development)
Regeneration in Planaria

Module 6 – Plant Embryonic Development
Two weeks: October 28 to November 17
Readings: Text pages 609-621, 622-628, 633-635

The first module in plant development will begin with exploring the fundamental difference between embryogenesis in plant and animals. Using the flowering plant *Arabidopsis* as a model species the module will explore how the gametophyte develops and generates gametes, which fuses to create a zygote that undergoes cell division to form an embryo and set aside `stem cells` to produce adult structures. The module will also introduce hormones that are central to plant development.

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Topics covered:
Phytohormones
Embryogenesis
Establishing the body plan
Meristems in the shoot and root
Early seedling development
Gametophyte development and fertilization

Module 7 - Organogenesis in Plants
Two weeks: November 18 - December 1
Readings: Text pages 628-646

This module will explore how stem cell populations called meristems allocate cells that give rise to organs, such as roots and leaves, and generate the adult plant. Groups of founder cells, called primordia, undergo cell division and give rise to different cell types in the leaf and root. The important role of hormones in this process will be examined. The module will also probe the modular program that governs flower development and illustrate how small changes allow for an infinite variety of floral forms.

Topics covered:
Flower and leaf development
Root system development

Module 8 - Patterning the Epidermis in Plants
One week: December 2 – December 8
Readings: journal articles

Lau O.S., Bergmann D.C. 2012. Stomatal development: a plant's perspective on cell polarity, cell fate transitions and intercellular communication. *Development*. 139(20):3683-3692.

Larkin J.C., Brown M.L, Schiefelbein J. 2003 How Do Cells Know What They Want to Be When They Grow Up? Lessons from Epidermal Patterning in Arabidopsis. *Annual Review of Plant Biology* 54(1): 403-430

Robinson D.O., Roeder A.H.K. 2015 Themes and variations in cell type patterning in the plant epidermis. *Current Opinion in Genetics & Development* 32:55-65

Epidermal cells such as stomata (gas exchange), root hairs (uptake) and trichomes (protection) are generated in a characteristic pattern. A similar patterning module (molecular complex) is used to produce each cell type and generate the regular spacing pattern.

Topics covered:
Stomatal development
Root hair patterning
Trichome production

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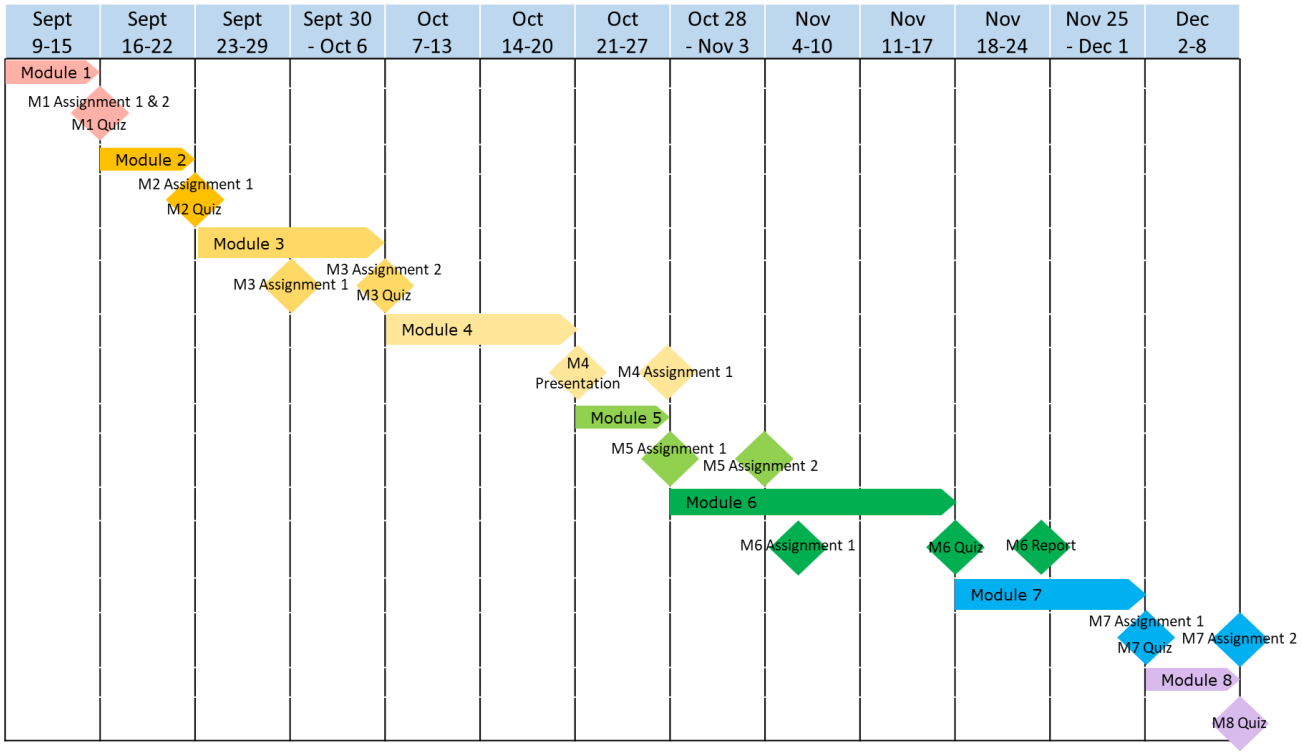
COURSE ASSESMENT

Each module will be assessed *independently* via quizzes, written assignments, presentation, and/or reports on analyzed data. The written assignments, reports, journal article critique and presentation are designed to help you gain a more complete understanding of the module topics. Detailed description of each assessment will be posted within the module folder on the course website at the start date for each module and you may complete the assessments at your own pace. However, all assessments must be submitted by 11pm (ADT; local Halifax time) on the stated due dates.



Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

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)		

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Assessments	Due dates	Value (%)	Module value (%)
Module 1 - Introduction to Developmental Biology *One week: September 9 to September 15*			
M1 Assignment 1 - Introductory presentation	Sept 15	1	
M1 Assignment 2 - Model Organisms	Sept 15	1	
Quiz	Sept 15	2	**4**
Module 2 - Gametogenesis and Fertilization *One week: September 16 to September 22*			
M2 Assignment 1 - Gametogenesis and Fertilization	Sept 22	5	
Quiz	Sept 22	3	**8**
Module 3 - Changes in the Early Embryo *Two weeks: September 23 to October 6*			
M3 Assignment 1 - Cleavage	Sept 29	3	
M3 Assignment 2 - Gastrulation and Neurulation	Oct 6	5	
Quiz	Oct 6	10	**18**
Module 4 - Specification and Patterning *Two weeks: October 7 to October 20*			
M4 Presentation – Germ layer specification	Oct 20	10	
M4 Assignment 1 – Specification and patterning	Oct 27 *(due date is outside of module window)*	5	**15**
Module 5 - Organogenesis and Regeneration *One week: October 21 to October 27*			
M5 Assignment 1: Regeneration	Oct 27	5	
M5 Assignment 2: Article Analysis	Nov 3 *(due date is outside of module window)*	5	**10**
Module 6 - Plant embryo development *Two weeks: October 28 to November 17*			
M6 Assignment 1 - Plant Embryogenesis	Nov 6	2	
M6 Report: Early Seedling Development	Nov 23 *(due date is outside of module window)*	15	
Quiz	Nov 17	7	**24**
Module 7 - Organogenesis in plants *Two weeks: November 18 - December 1*			
M7 Assignment 1 – Flower and Leaf Development	Dec 1	5	
M7 Assignment 2 – Root System Development	Dec 8 *(due date is outside of module window)*	4	
Quiz	Dec 1	5	**14**
Module 8 - Patterning the epidermis *One week: December 2 – December 8*			
Quiz	Dec 8	7	**7**

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Course Policies

Running this course online is a new endeavor for all of us, and we are aware that the new mode of learning may pose many challenges for everyone. We are working to provide the best experience possible in an online course, and we recognize that open communication is an important part of that. We will be communicating with you regularly, and hope that you will feel comfortable asking for help, whether with content or challenges you are experiencing with online learning, when you need it.

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 talk to Dr. Stone or Dr. Cooper if you have problems with any of these regulations at any time during the term.

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. 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. quiz, deadline for submission of an assignment, etc.) **NOTIFIES THE INSTRUCTOR OR PROFESSOR ON THE DAY IN QUESTION**, and submits a Student Declaration of Absence (SDA) to the appropriate Assignment drop box. 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 submission deadlines notifies the instructor at least one week in advance.

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.**

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Plagiarism and Academic Integrity:

You are expected to abide by Dalhousie University's policies on academic integrity.

We encourage you to work with classmates to help each other learn the content of the class. The Discussion boards will be particularly important for asking questions and receiving help from Dr. Stone, Dr. Cooper, the teaching assistants and your peers. You will also do formal group work for **M4 Presentation – Germ Layer Specification** and **M7 Assignment 1 – Flower and Leaf Development**. ***These are the only two assignments for which you will make a group submission. All other assignments that you submit must be independent and entirely your own wording.*** You can work together to understand content, but these assignments must be your own work.

The M6 Report – Early Seedling Development will be assessed using Urkund plagiarism software.

Despite the fact that the quizzes cannot take place in a proctored setting this year, they are independent assessments. You may consult your notes, textbook, or other course content, but you cannot collaborate with classmates or post questions to external websites.