Welcome to BME205H1S

Cell and Systems Biology

P.M. Gilbert

January 10, 2017

What is biomedical engineering?

- Tissue Engineering
- Genetic Engineering
- Neural Engineering
- Pharmaceutical Engineering
- Medical Devices (medical imaging, implants, bionics)
- Clinical Engineering

Biology and engineering

- Engineers are superb problem solvers
- Biologists are discoverers (problem 'revealers')
- Engineers think differently about biology:
  - Physical scientists approach problems in a unique way
  - Cell structure relates to cell function (motors, compartments, stress, strain etc.)
- Biomedical engineers need to converse in biological language 1) to work with biologists and 2) to form their own unique questions.

What is this course about?

- To provide a **foundation** for studies in biomedical engineering
- Develop an understanding of fundamental **cellular and molecular biology**
- Learn how to **extract critical information and principles** from a large amount of textual information or detail
- Develop problem solving skills
- Learn experimental design

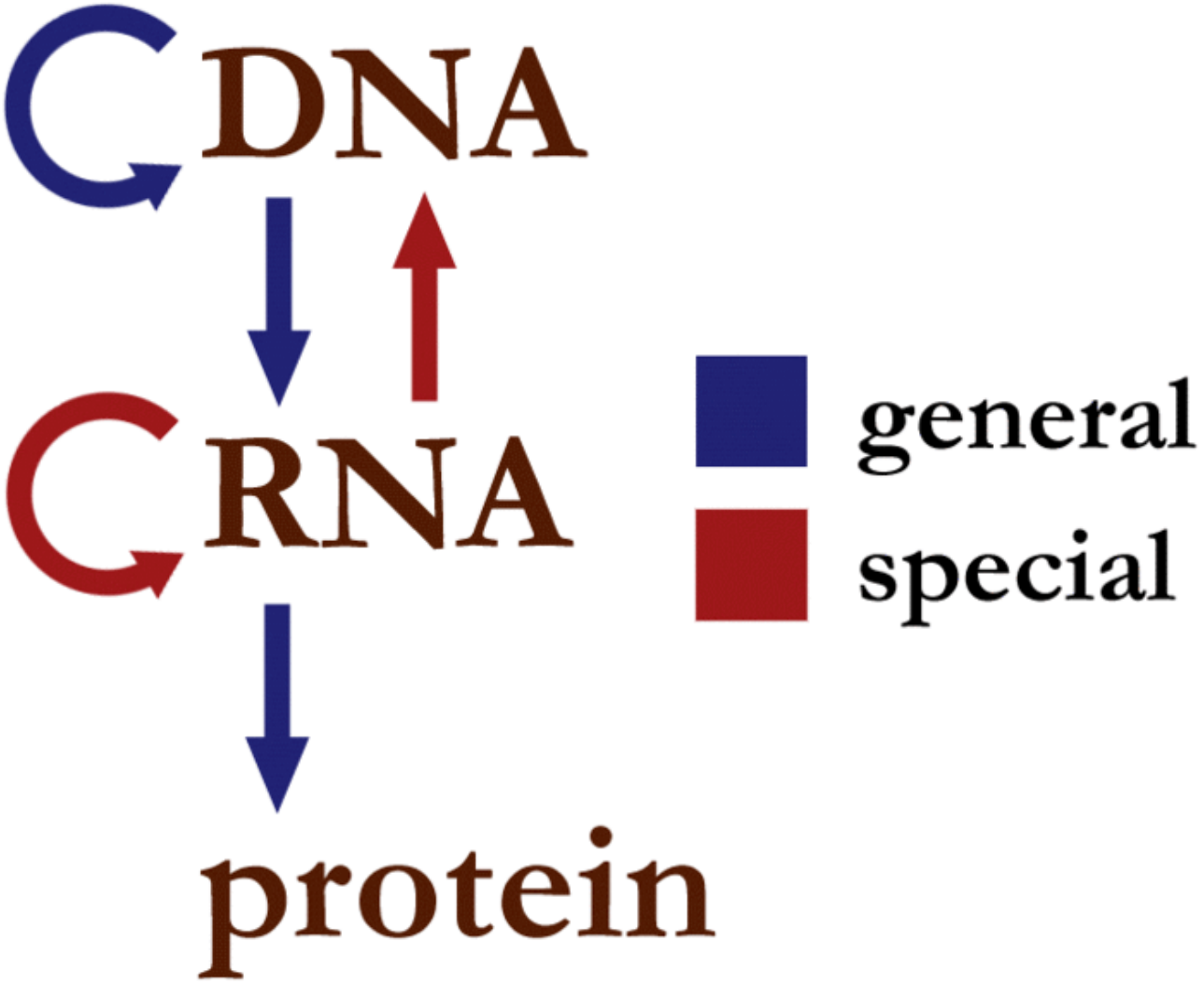
How this 'biology' course is different?

- Did you take grade 12 math (algebra and calculus)?
- Did you take grade 12 physics (1 or 2 years)?

- Did you take grade 12 biology biology?

For many: This will be your **first** course in "biology".

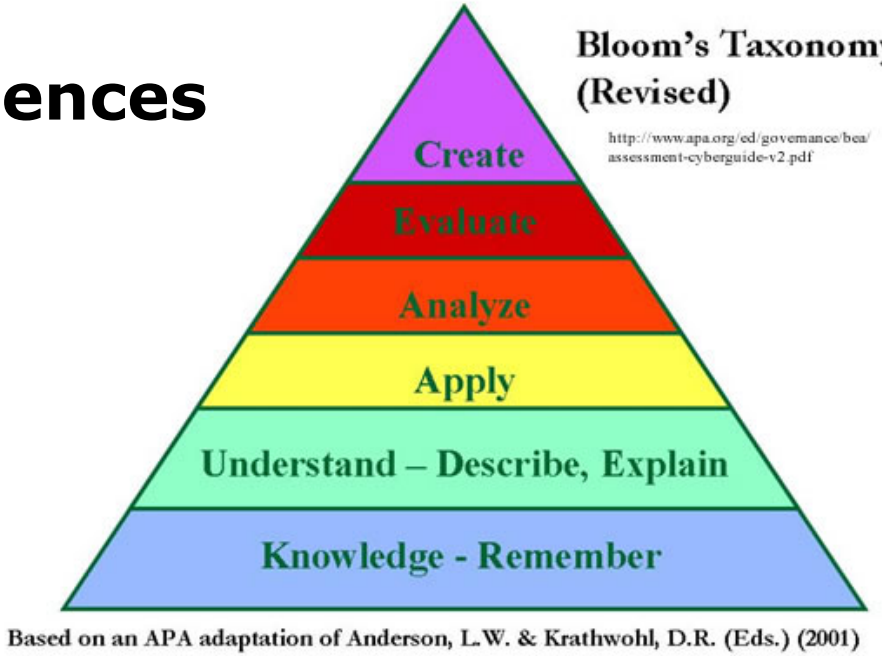
How many people understand this?



How this 'biology' course is different?

- **Where are you on Bloom's taxonomy of learning?**

Physical Sciences



Based on an APA adaptation of Anderson, L.W. & Krathwohl, D.R. (Eds.) (2001)

Biology

Course structure

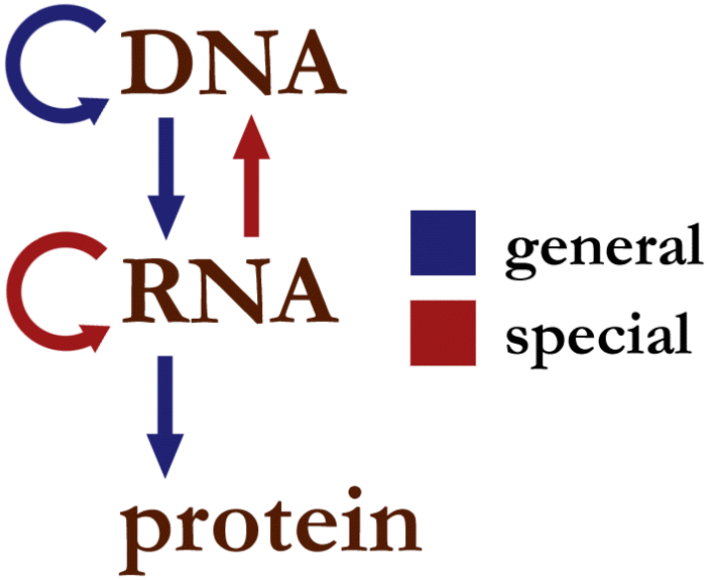
- Lectures (listen)
- Labs (hands-on)
- Tutorial (synthesize concepts)

Lecture, tutorial, lab schedule

Date	Type	Lecturer	Topic*	Laboratories	Tutorials
Tue, 10-Jan	Lecture 1	PMG	Course overview & setting expectations		
Thu, 12-Jan	Lecture 2	PMG	Part I, The musculoskeletal system: from tissues to cells (Ch1)		
Week of Jan 16	Tutorial 1		Review of concepts and aspects of design (Lectures 1-3)	Lab 1: EMG or Lab 2: Microscopy	Units of Measurement
Tue, 17-Jan	Lecture 3	PMG	Part I, Chapter 1, Introduction to the study of cell & systems biology		
Thu, 19-Jan	Lecture 4		Part I, Chapter 2, The chemical basis of life		
Week of Jan 23	Tutorial 2		Review of concepts and aspects of design (Lectures 4-5)	Lab 1: EMG or Lab 2: Microscopy	Review of Concepts
Tue, 24-Jan	Lecture 5	PMG	Part I, Chapter 2, The chemical basis of life		
Thu, 26-Jan	Lecture 6	PMG	Part I, Chapter 3, Bioenergetics, enzymes, and metabolism		
Week of Jan 30	Tutorial 3		Review of concepts and aspects of design (Lecture 6-7)	Lab 1: EMG or Lab 2: Microscopy	Western Blotting
Tue, 31-Jan	Lecture 7	PMG	Part I, Chapter 4, The structure and function of the plasma membrane		
Thu, 2-Feb	Lecture 8	PMG	Part I, Chapter 4, The structure and function of the plasma membrane		
Thu, 16-Feb	Lecture 12	PMG	Part I, Chapter 7, Interactions between cells and their environment		
Week of Feb 20	READING WEEK			No Labs	No Tutorials
Tue, 21-Feb			Reading week begins		
Thu, 23-Feb			Reading week ends		
Week of Feb 27	Tutorial 6		Review of concepts and aspects of design (Midterm Review Lectures 1-12)	Lab 3: Cheek Cell Isolation & Proteomics	Jeopardy!
Tue, 28-Feb	Lecture 13	PMG	Part II, Chapter 7, Interactions between cells and their environment		
Thu, 2-Mar	Lecture 14	PMG	Part II, Chapter 8, Cytoplasmic membrane systems		
Week of Mar 6	Tutorial 7		March 9th, 9-11am (EX100)	No Labs	Nanomedicine
Tue, 7-Mar	Lecture 15	PMG	Part II, Chapter 8, Cytoplasmic membrane systems		
Thu, 9-Mar	Lecture 16	PMG	Part II, Chapter 10, The nature of the gene & the genome		
Week of Mar 13	Tutorial 8		Review of concepts and aspects of design (Lectures 16-17)	Lab 4: PCR	Mitochondrial Diseases & Crispr/Cas9
Tue, 14-Mar	Lecture 17	PMG	Part II, Chapter 11, Gene expression: from transcription to translation		
Thu, 16-Mar	Lecture 18	PMG	Part II, Chapter 11, Gene expression: from transcription to translation		
Week of Mar 20	Tutorial 9		Review of concepts and aspects of design (Lectures 18-19)	Lab 4: PCR	PCR
Tue, 21-Mar	Lecture 19	PMG	Part II, Chapter 12, Control of gene expression		
Thu, 23-Mar	Lecture 20	PMG	Part II, Chapter 9, The cytoskeleton and motility		
Week of Mar 27	Tutorial 10		Preparation Quiz. (5%, Covers Lectures 12-19; Labs 2-4; Tutorials 7-9)	Lab 5: Forensic DNA fingerprinting	Preparation Quiz
Tue, 28-Mar	Lecture 21	PMG	Part II, Chapter 9, The cytoskeleton and motility		
Thu, 30-Mar	Lecture 22		Part II, Chapter 9, The cytoskeleton and motility - Stem cell mechanobiology		
Week of Apr 3	Tutorial 11		Review of concepts and aspects of design (Lectures 20-22)	Lab 5: Forensic DNA fingerprinting	Cell Contractility
Tue, 4-Apr	Lecture 23	PMG	Part II, Chapter 14, Cellular reproduction		
Thu, 6-Apr	Lecture 24	PMG	Part II, Chapter 14, Cellular reproduction - Engineering biosensors		
Week of Apr 10			Review of concepts and aspects of design (Lectures 23-24)	No Labs	No Tutorials
Tues, 11-Apr	Lecture 25	PMG	Part II, Chapter 14, Cellular reproduction - Stem cell bioprocessing		
Thurs, 13-Apr	Lecture 26	PMG	Part II, Review Session (Jeopardy!)		
Mon, 17-Apr			Exam period begins		
TBD			TBD		
Fri, 28-Apr			Exam period ends		

Lab schedule

Lab 1: EMG Laboratory (MB70)
Lab 2: Microscopy (MB325)
Lab 3: Proteomics (MB325)
Lab 4: Polymerase chain reaction (PCR; MB325)
Lab 5: Forensic DNA fingerprinting (MB325)



Lab schedule

BME205 Lab Schedule (2017)
Updated January 1, 2017

	PRA01 (Tues 2pm)	PRA02 (Tues 2pm)	PRA03 (Wed 2pm)	PRA04 (Wed 2pm)	PRA05 (Wed 9am)	PRA06 (Wed 9am)	Topic	TA
Jan 9	No Lab	No Lab	No Lab	No Lab	No Lab	No Lab		
Jan 16	Lab 1 or 2	No Lab	Lab 1 or 2	No Lab	Lab 1 or 2	No Lab	EMG or Microscopy	Sadegh / Filip
Jan 23	No Lab	Lab 1 or 2	No Lab	Lab 1 or 2	No Lab	Lab 1 or 2	EMG or Microscopy	Sadegh / Filip
Jan 30	Lab 1 or 2	No Lab	Lab 1 or 2	No Lab	Lab 1 or 2	No Lab	EMG or Microscopy	Sadegh / Filip
Feb 6	No Lab	Lab 1 or 2	No Lab	Lab 1 or 2	No Lab	Lab 1 or 2	EMG or Microscopy	Sadegh / Filip
Feb 13	Lab 3	No Lab	Lab 3	No Lab	Lab 3	No Lab	Cheek Cell Isolation & Proteomics	Jennifer / Aileen
Feb 20	FAMILY DAY & READING WEEK							
Feb 27	No Lab	Lab 3	No Lab	Lab 3	No Lab	Lab 3	Cheek Cell Isolation & Proteomics	Jennifer / Aileen
Mar 6	No Lab	No Lab	No Lab	No Lab	No Lab	No Lab		
Mar 13	Lab 4	No Lab	Lab 4	No Lab	Lab 4	No Lab	Polymerase Chain Rxn	Richard / Wilson
Mar 20	No Lab	Lab 4	No Lab	Lab 4	No Lab	Lab 4	Polymerase Chain Rxn	Richard / Wilson
Mar 27	Lab 5	No Lab	Lab 5	No Lab	Lab 5	No Lab	DNA Fingerprinting	Cindy / Mable
Apr 3	No Lab	Lab 5	No Lab	Lab 5	No Lab	Lab 5	DNA Fingerprinting	Cindy / Mable
Apr 10	No Lab	No Lab	No Lab	No Lab	No Lab	No Lab		

*See next page for teaching assistant contact information

MB325 Teaching Lab Required Training

- **Watch Safety Video: https://youtu.be/awVcEdDuAoU**
- **EHS 101 (WHMIS)**
- **ESH 002 U of T EHS Orientation**
- **Pass Safety Quiz (First 10 min of Lab #2 – Microscopy)**

Consent form (Cheek Cell & PCR Labs)

This project is one of the requirements towards the course BME205S/BME105 Systems Biology, one of the requirements for the Bachelor of Applied Science and Engineering in Engineering Science. Approximately 200 students will be involved in this project.

This project will take place over the four-week period from January 2015 to April 2015 in Mining Building Room 325. The participants will obtain cheek cells from themselves, and extract the total protein and DNA using standard laboratory techniques. The students will then perform genetic tests on their DNA as well as some provided (anonymously) by classmates. The results can be visualized via the total protein or PCR-product gel electrophoresis. These genetic tests will only be for things that a person could be reasonably expected to learn otherwise in their normal life. Examples of this type of gene would be one that imparts a difficulty in metabolizing alcohol, or one which confers an allergy.

Participation in this project is entirely voluntary and students may withdraw their genetic material at any time with no adverse consequences.

Students might test their gene of choice on their own DNA. All other results will be anonymized. Only the Teaching Laboratory Coordinator and the course instructor will have access to the matrix which connects sample number to student names. This matrix and all samples will be stored in a secure location for the duration of this project in the laboratory (MB325). The matrix and any left-over samples will be destroyed by shredding (matrix) or autoclaving (samples) upon the conclusion of the course.

Consent form (EMG Lab)

Consent Form

Recording and analyzing personal data for undergraduate courses

In your course laboratories, you will be collecting and analyzing personal data. Before participating, it is important that you understand what will be involved. This consent form will provide information to help you make an informed choice.

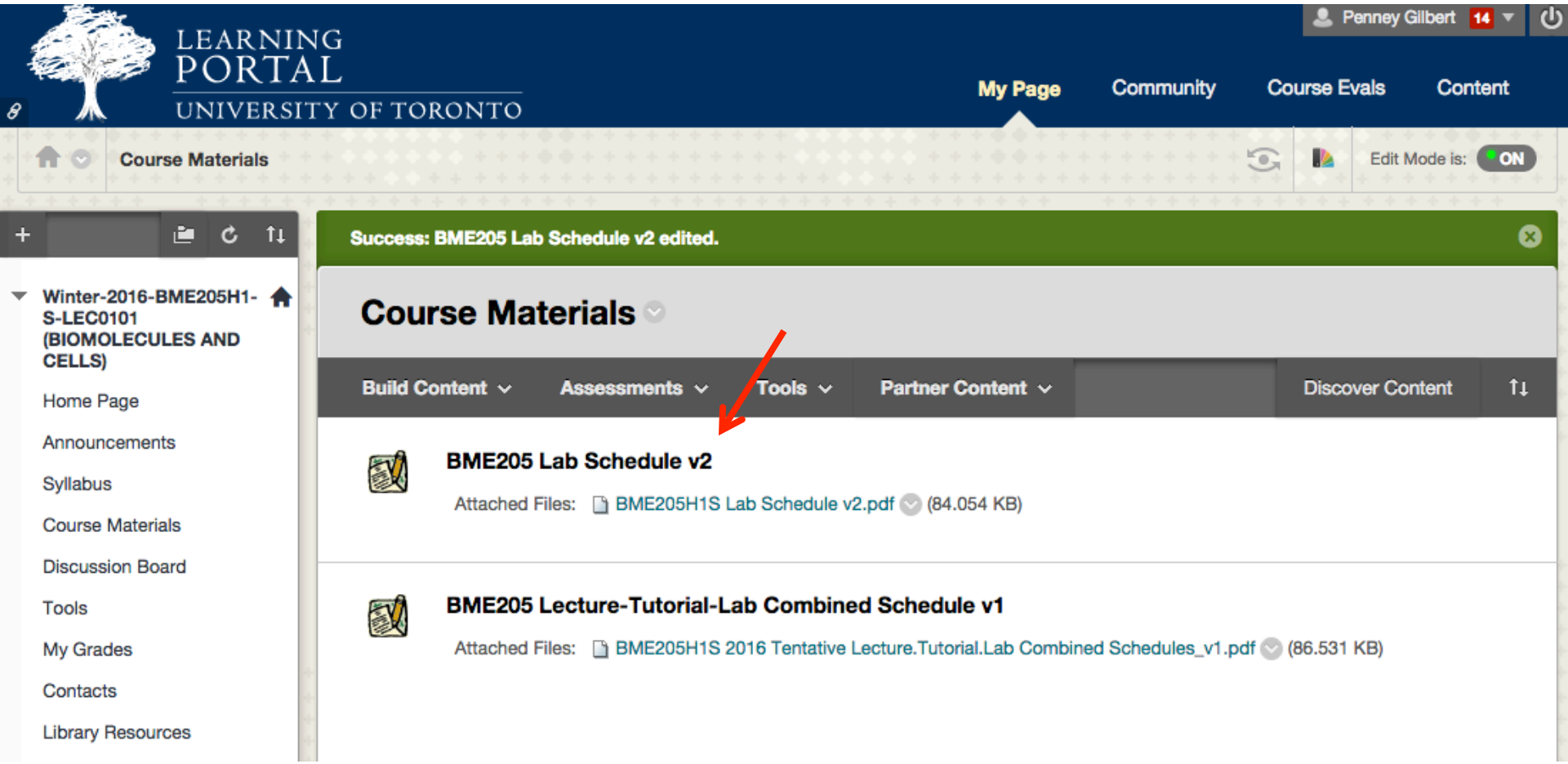
How will I be involved?

You will be collecting personal data such as demographic information (*e.g.* age, gender, *etc*), physiological data (*e.g.* brain activity, heart activity, *etc*), and inertial data (*e.g.* force measurements).

What are the risks?

The personal data you are collecting will be collected and stored on laptops used in the IBBME Design Studio (Minning Building, rooms 64 and 78). During the labs, other students may see the data you collect and the results of any analyses. Additionally, the computers are used by other individuals that also make use the IBBME Design Studio, such as undergraduate students and grade school students that come to the Design Studio for demonstrations. There is a potential that other individuals may see your data. Any data on the computers are deleted at the end of each school year (June). It is your responsibility to de-identify your own data (*i.e.* avoid or eliminate any connection between your identification and the data.) This can be done by not using your full name to label the data. Additionally, your professor or TA may want to use your data as an example in lecture or tutorial presentations. If your data are used for course material, your identity will not be made public.

Blackboard maintenance



Tutorial (Starting week of Jan. 16th)

- To discuss concepts from class & labs
- Work on team projects designed to solidify knowledge
- The TAs are your central contact point with the course
- Bring any concerns or questions to them

- **Attendance is mandatory**
- Your mark will be based on weekly pop quizzes (10%) and 2 quizzes (2 x 5%)

Tutorial				
TUT0101	**Wed**	**9:00 – 10:00**	BA2155	Alex Vlahos
TUT0102	**Wed**	**9:00 – 10:00**	GB304	Stephanie Iwasa
TUT0103	**Wed**	**9:00 – 10:00**	BA2165	Michelle Kim
TUT0104	**Wed**	**13:00 – 14:00**	BA2165	Ben Luby
TUT0105	**Tues**	**13:00 – 14:00**	BA2145	Gabi Lam
TUT0106	**Tues**	**13:00 – 14:00**	BA2139	Buddhisha Udugama

Instructors & course facilitators

- Professor **Penney Gilbert** (IBBME, CCBR)
  - Muscle stem cell bioengineering & tissue engineering

- Tutorial Head TA: **Ben Luby** (ben.luby@mail.utoronto.ca)

- Lab Head TA's: **Sadegh Davoudi** (sadegh.davoudi@mail.utoronto.ca)

- Textbook – Cell and Molecular Biology: Concepts and Experiments, 7th Edition, by Gerald Karp (ISBN : 978-1-118-54961)

- Prof. Gilbert Office hours: Arrange in class or by email

Grading

- 20 % - **Tutorial** (10% pop quizzes + 2 x 5% Quizzes)
- 20 % - **Labs** (5 labs = lab work, safety, lab reports)
- 25 % - **Midterm**
  - Monday March 9th, 9-11 am EX100
  - Covers Part I (Lectures 1-12) of the course
  - Type A Exam – *Closed book, no aids permitted*.
- 35 % - **Final**
  - Covers all the material, but focused on Lect. 12-24
  - Date/time TBD
  - Type A Exam – Closed book, no aids permitted.

How can you succeed in this course?

- Your level of learning dictates that much of this course will require **memorization**
- You need to learn the "vocabulary" or "building blocks" of biology prior to being able to design
- *WARNING:* You will require different study habits
- *Repetitio est mater studiorum.*
  - Translation: "Repetition is the mother of study."
- How does the course structure attempt to help?

How does the course structure attempt to help?

- ***Repetitio est mater studiorum* :**
  - Lectures - first time to hear the material (top students will read the chapter before arrival)
  - Tutorials - allow you to digest the material and discuss it in small groups
  - Quizzes - you may only have it in your short-term memory – *intellectual bulimia*
  - Labs – hands-on opportunity (5 labs)
  - Mid-terms and Final (long-term understanding)

- Skipping lectures and tutorials: missing a (*free?*) opportunity to learn the material

How should you change your study habits?

- ***Repetitio est mater studiorum*:**

- Reserve multiple (separated) times to study:
  - You won't be able to cram this material into your brain in a single night of study

- Your repetition (studying) must be slow
  - It is easy to gloss over material and fool yourself into believing you understand the material – test yourself (look – pull away)
  - TIP: Slow yourself down by writing the lecture notes

- Focus on the lecture notes and use the book as a reference guide
  - You will be less overwhelmed.

Academic integrity

1. **Read Margaret Proctor's "How Not to Plagiarize" documents.** Many students think they know how to cite and reference properly when in fact they are still making serious mistakes. Your college writing centre can also be very helpful.
2. Familiarize yourself with the **Code of Behaviour on Academic Matters** - it outlines all the rules students must follow while at U of T. You are expected to know these rules and follow them.
3. Any idea you borrow from another source must be acknowledged with a precise reference (footnote, endnote, etc) and listed in your bibliography. **If you borrow words or phrases, they must also be placed within quotation marks**. It is better to have too many references in your paper than too few.
4. If you are working with other students on lab reports or computer science projects, **do not exchange answers or write your reports together**. A computer analysis is frequently done on submissions to detect similarities between reports.
5. **Do not use Wikipedia!** It is notoriously unreliable and is unacceptable for university level research. If you use the internet, make sure your sources are reliable and scholarly, and that you know how to reference these sources accurately.
6. If you are considering handing in an assignment that is similar to one you have previously submitted, consult your instructor. **It is an offence to submit work for which credit has already been given**, or is being sought.
7. Make sure you **do not take any electronic devices into tests or examinations**, including cell phones and MP3 players. They are considered "unauthorized aids" and their possession is an offence at U of T examinations and tests.
8. **It is an offence to provide another student with unauthorized assistance**, and this can include providing other students with copies of your assignments. Protect your integrity - do not share your work with other students.
9. If you find yourself strapped for time you can ask for an extension, accept the late penalty, or simply not submit the assignment. **It is far better to accept a reduced mark than to commit an academic offence** so that you can meet deadline.
10. If in doubt about anything, **consult your instructor, teaching assistant, registrar, or college writing centre for advice**. U of T has many services to assist students with life at university.

Petitions

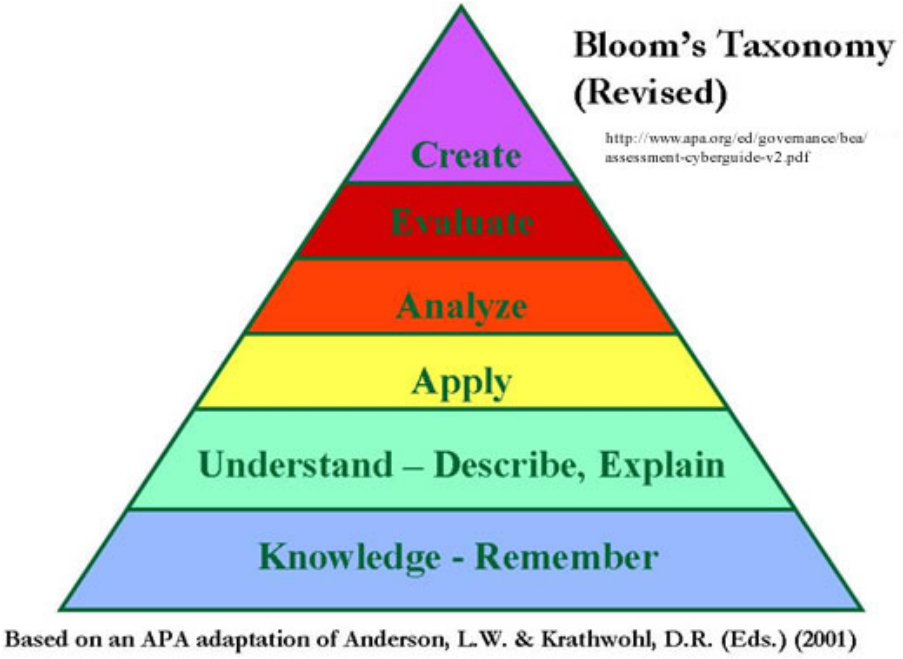
Link for FASE Petition Info & Submission:

http://www.apsc.utoronto.ca/portal

1. Complete coursework petition
2. Verification of illness form
3. Submit petitions **and supporting documentation** via Engineering Portal
4. Prof. Gilbert does not make decisions about whether or not a petition is granted, but will be notified of the decision and adjust marks, etc accordingly

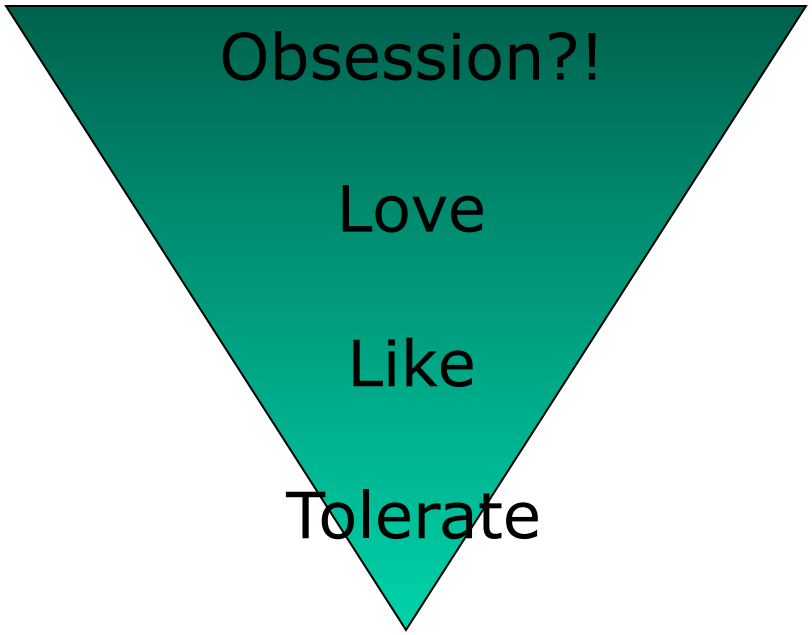
We aim towards understanding and application…

Learning



Based on an APA adaptation of Anderson, L.W. & Krathwohl, D.R. (Eds.) (2001)

Enjoyment



Our aim is to build a foundation to enjoy higher levels of biomedical engineering.

Biomedical Engineering Minor vs. Biomedical Engineering Systems Major

Biomedical Engineering Minor	Biomedical Engineering Systems Major
• **Pursue this minor in conjunction with another EngSci major** (except for the BME Major) • **Open to students across U of T Engineering**—take classes and collaborate on projects with students from other engineering disciplines • **Lighter requirements**—four half-year courses PLUS a research project OR capstone course in years 3 and 4 • Eligible for IBBME faculty-student mentorship program	• **EngSci students** only • **Intensive training focused on biomedical engineering only**—cannot combine with BME minor • **Extensive requirements**—14 required courses, plus a thesis and additional electives in years 3 and 4