

## Fundamentals of Medicine and Dentistry

### Basic Scientific Principles that All Students Should Know Upon Entering Medical and Dental School at McGill

Students entering medical and dental training come from a variety of educational backgrounds. The skills and knowledge that persons from varied backgrounds bring to the health professions offer many opportunities for positive contributions to their growth, overall excellence, and innovation in patient care and research.

Science and the scientific method, enacted through the compassionate lens of humanism, form the basis of medical knowledge and practice. Students admitted to our program must thus have the required prerequisite science courses in order to be considered for admission (available at: [www.mcgill.ca/medadmissions](http://www.mcgill.ca/medadmissions) ).

Given the varied educational backgrounds of our admitted students, we provide below **a list of scientific concepts which admitted students are expected to have been exposed to through the course of their prerequisite, general CEGEP and university level courses, and through their own self-directed learning.** These concepts have been identified by the MD CM curriculum leadership as foundational to the study of Medicine and Dentistry at McGill. This list is meant to assist admitted students in identifying areas they may wish to master on their own prior to starting in the MD CM or DMD curricula. **This list will also be useful to potential applicants in the course of planning their academic programs prior to applying to the MD CM or DMD programs at McGill.**

**For admissions purposes, two options are available to fulfill the science prerequisite requirements:**

#### OPTION 1: Basic Sciences

Candidates are required to have completed **7 basic sciences** required courses:

- 2 basic Biology courses with labs (at least 6 cr.);
- 2 basic Chemistry courses with labs (at least 6 cr.);
- 1 basic Organic Chemistry course with lab (at least 3 cr.);
- 2 basic Physics courses with labs (at least 6 cr.).

#### OPTION 2: Recommended University-level sciences

**IF** you have previously completed all courses in OPTION 1, and wish to either improve your science GPA, or if some of your courses in OPTION 1 have expired (older than eight years), you may choose to do the recommended courses in OPTION 2 and complete the 4 recommended university-level science courses (mammalian physiology, organic chemistry, molecular biology, and cell biology & metabolism). However, in order for the Admissions office to use the science GPA of OPTION 2, all 4 of the recommended courses must be valid (completed within the last 8 years).

**IF you have completed both [OPTION 1](#) and [OPTION 2](#), you will be evaluated using whichever set of courses is the most favorable to you.**

## Basic Concepts you should be familiar with before starting medical or dental school:

### BIOLOGY

#### *Basics of the Cell*

- What is a cell?
- What are the differences between prokaryotic and eukaryotic cells?
- What is the cell membrane and what are its basic properties?
  - What are lipids? What is a lipid bilayer?
- What is the basic function of the following subcellular organelles?
  - nucleus
  - mitochondria
  - endoplasmic reticulum
  - Golgi apparatus
  - ribosome

#### *DNA and the Central Tenets of Molecular Biology*

- What is DNA?
- Where is DNA found in the cell?
- What are the four nucleotide bases of DNA?
- What is base-pairing?
- What are the basics of DNA replication?
- What is a codon?
- What is a gene?
- How does DNA store genetic information?
- How is the genetic information in DNA transcribed into messenger RNA and then translated into proteins?
- What are the structural differences between DNA and RNA?
- Epigenetics- how does DNA methylation, histone acetylation and chromosome organization impact gene expression?
- Evolution- what is natural selection? What is descent with modification?

#### *Proteins*

- What are amino acids?
- What is a protein?
- What functions do proteins carry out in cells?
- What is an enzyme?
- How do enzymes regulate biochemical reactions?

#### *Genetics*

- What are chromosomes?
- What are gametes?
- At the level of the chromosomes, what determines whether an organism will be male or female?
- What are the consequences of aneuploidy (not having a normal chromosome complement)?
- At a basic level, how are genetic traits inherited?
- What is a dominant gene/genetic disorder?
- What is a recessive gene/genetic disorder?

- What is a sex-linked genetic trait/disorder?
- What is multifactorial inheritance?
- What does it mean to clone a gene?

### ***Cell Division***

- What are the basic characteristics of cell division?
- What is the cell cycle?
- What is mitosis?
- What is meiosis?
- What is the difference between mitosis and meiosis?
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### ***Cellular Signalling***

- How do cells communicate with each other?
- What is a hormone?
- What are ligands and receptors?
- How are receptors activated? What are the consequences of receptor activation?
- What is a 2nd messenger?
- What is a signalling pathway?

### ***Energy Metabolism***

- At a basic level, how does the body extract energy from nutrients?
- What is ATP?
- What is the difference between aerobic and anaerobic cellular respiration?
- What is glycolysis?
- What is the citric acid (Krebs) cycle?
- What is oxidative phosphorylation?
- What is the role of mitochondria in cell metabolism
- What is catabolism?
- What is anabolism?
- What are the roles of enzymes in catabolism and anabolism?

### ***Developmental Biology***

- What are the universal principles of animal development?
- What are the basic mechanisms underlying formation of the body plan?

## **CHEMISTRY**

- Basics of chemical reactions: equilibrium, rate constant, catalyst
- What is oxidation? Reduction?
- What is the Nernst equation?
- What is the chemical composition of carbohydrates? Proteins? Fatty acids? Nucleic acids?
- What is osmolarity, and how is it determined?
- What is an acid? Base? pH?
- Understand the chemical basis of metabolic reactions in living cells
- Have a basic understanding of atomic theory

- Have a basic understanding of the chemistry of alcohols, ethers, carbonyl compounds, and amines, aliphatic and aromatic compounds including modern concepts of bonding.

## PHYSICS

- Have knowledge of core physical constants, physical quantities and vectors
- Have an understanding of Newtonian laws of motion and the concepts of work, energy, kinetic energy, potential energy, and power.
- Have an understanding of electrical charge, electrostatic force, electrical and magnetic fields, conductors, insulators, electric current, voltage, resistance, capacitance, Kirchhoff's Laws, resistors and capacitors in series and in parallel, time constant of a RC circuit, and use of an ammeter and voltmeter.
- Have an understanding of simple harmonic motion as applied to sound and light waves.

*Not required as part of the admissions pre-requisite courses, however admitted students are expected to have been exposed to these concepts prior to starting in the MD CM or DMD curricula.*

### **Statistics**

- What is a mean? Median? Mode?
- What is a normal distribution? Standard deviation?
- What are p-values and confidence intervals?
- What is probability?
- How are graphs read?

## EXAMPLES of Basic Sciences **OPTION 1** Courses

<i>in Biology</i>	<i>in Chemistry</i>	<i>in Physics</i>
<ul style="list-style-type: none"> <li>• <i>a minimum six (6) semester hours of introductory coursework, with labs;</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>a minimum six (6) semester hours of general (or physical) chemistry coursework, with labs,</i></li> <li>• <i>a minimum three (3) semester hours of organic chemistry coursework, with labs;</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>a minimum six (6) semester hours of introductory coursework, with labs;</i></li> </ul>

### OPTION 1 CEGEP or CEGEP- EQUIVALENT COURSES FOR MDCM APPLICANTS<sup>1</sup>

The following CEGEP courses, or their equivalents (with labs), fulfill Option 1:

#### BIOLOGY

- General Biology 1 (101-NYA; OOUK)
- General Biology 2 (101-NYB; OOXU)

#### CHEMISTRY

- Chemistry 1 (202-NYA; OOUL)
- Chemistry 2 (202-NYB; OOUM)
- Organic Chemistry 1 (OOXV)

#### PHYSICS

- Mechanics (203-NYA; OOUR)
- Electricity and Magnetism (203-NYB; OOUS)
- Waves and Optics and Modern Physics (203-NYC; OOUT)

***Not required as part of the admissions pre-requisite courses, however admitted students are expected to have been exposed to these concepts prior to starting in the MD CM or DMD curricula.***

#### MATHEMATICS

- Calculus I (201-NYA; OOUN)

See [www.mcgill.ca/students/transfercredit/prospective/cegep](http://www.mcgill.ca/students/transfercredit/prospective/cegep) for CEGEP-by-CEGEP listing of which courses are acceptable.

<sup>1</sup> For applicants to the Medicine-Preparatory program (direct entry after CEGEP), course requirements are slightly different, consult [www.mcgill.ca/medadmissions/applying/requirements-edu/med-p-requirements](http://www.mcgill.ca/medadmissions/applying/requirements-edu/med-p-requirements) for details.

## OPTION 1 UNIVERSITY LEVEL COURSES

At McGill University, the courses **most commonly recognised** for OPTION 1 are listed here. *All of these courses offered at McGill are considered equivalent to 100-level CEGEP courses.*

- BIOL 111 - Principles: Organismal Biology (3 credits) [www.mcgill.ca/study/courses/biol-111](http://www.mcgill.ca/study/courses/biol-111)
- BIOL 112 - Cell and Molecular Biology (3 credits) [www.mcgill.ca/study/courses/biol-112](http://www.mcgill.ca/study/courses/biol-112)
- CHEM 110 - General Chemistry 1 (4 credits) [www.mcgill.ca/study/courses/chem-110](http://www.mcgill.ca/study/courses/chem-110)
- CHEM 120 – General Chemistry 2 (4 credits) [www.mcgill.ca/study/courses/chem-120](http://www.mcgill.ca/study/courses/chem-120)
- CHEM 212 - Introductory Organic Chemistry [www.mcgill.ca/study/courses/chem-212](http://www.mcgill.ca/study/courses/chem-212)  
*\*\*\*CHEM 212 requires CHEM 120 as a co-requisite*
- PHYS 101 - Introductory Physics - Mechanics (4 credits) [www.mcgill.ca/study/courses/phys-101](http://www.mcgill.ca/study/courses/phys-101)
- PHYS 102 - Introductory Physics - Electromagnetism (4 credits) [www.mcgill.ca/study/courses/phys-102](http://www.mcgill.ca/study/courses/phys-102)

## EXAMPLES of Recommended Sciences OPTION 2 Courses

**IF you have previously completed all courses in OPTION 1, even if some of those courses have expired** (older than 8 years), you may choose to complete the 4 recommended university-level science courses (with labs):

At McGill University, the four recommended courses are:

- PHGY 209 -Mammalian Physiology (3 credits) [www.mcgill.ca/study/courses/phgy-209](http://www.mcgill.ca/study/courses/phgy-209)
- BIOL 200 -Molecular Biology (3 credits) [www.mcgill.ca/study/courses/biol-200](http://www.mcgill.ca/study/courses/biol-200)
- BIOL 201 - Cell biology & Metabolism (3 credits) [www.mcgill.ca/study/courses/biol-201](http://www.mcgill.ca/study/courses/biol-201)
- CHEM 212 - Introductory Organic Chemistry 1 (3 credits) [www.mcgill.ca/study/courses/chem-212](http://www.mcgill.ca/study/courses/chem-212)

*\*\*\*For applicants using CEGEP courses to fulfil OPTION 1 Basic Sciences: A **university level** Introductory Organic Chemistry is required for OPTION 2 Recommended Sciences. Some students may choose to do CHEM 222 – Introductory Organic Chemistry 2 (4 credits) to fulfil this requirement.*

**Note in order for the Admissions Office to use the science GPA of the recommended courses in OPTION 2, all four must be completed and valid (done within the last eight years).**

Additionally, students entering the MD CM and DMD programs should know **Physiology, Statistics and Genetics** at a level equivalent to the first-year introductory courses at McGill. Without these courses, it may be difficult to keep up with course material throughout the MD CM program. Note that these are not required admission pre-requisite courses.

At McGill University, these courses are:

### Physiology

- PHGY 210 Mammalian Physiology 2 (3 credits) [www.mcgill.ca/study/courses/phgy-210](http://www.mcgill.ca/study/courses/phgy-210)

**Statistics (any one of the following courses)**

- BIOL 373 Biometry (3 Credits) [www.mcgill.ca/study/courses/biol-373](http://www.mcgill.ca/study/courses/biol-373)
- PSYC 204 Intro to Psychological Stats (3 Credits) [www.mcgill.ca/study/courses/psyc-204](http://www.mcgill.ca/study/courses/psyc-204)
- MATH 203 Principles of Statistics 1 (3 Credits) [www.mcgill.ca/study/courses/math-203](http://www.mcgill.ca/study/courses/math-203)

**Genetics**

- BIOL 202 Basic Genetics (3 credits) [www.mcgill.ca/study/courses/biol-202](http://www.mcgill.ca/study/courses/biol-202)

**IMPORTANT NOTE: You are required to have at least 5 out of 7 of your basic science pre-requisites finalized (with official grades submitted) by the application deadline of November 1st. No more than 2 courses can be outstanding by the time of application, and if applicable, the official grades for these remaining science pre-requisites must be submitted to our office by January 15 at the latest.**

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For the complete policy on Basic Science pre-requisite courses required for Admissions, visit:

[www.mcgill.ca/medadmissions/applying/requirements-edu/basic-science-prerequisites](http://www.mcgill.ca/medadmissions/applying/requirements-edu/basic-science-prerequisites).

All official information regarding the application process can be found on our website. In the eventual discrepancy, the website is the official source. [www.mcgill.ca/medadmissions/applying](http://www.mcgill.ca/medadmissions/applying)

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