

Master of Medical **BIOTECHNOLOGY** University of Windsor

Study Guide

Department of Chemistry & Biochemistry



University
of Windsor

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Welcome

A warm welcome to all new students in the Masters of Medical Biotechnology (MMB) Program at the University of Windsor. Dr. Trnum Kaur, MMB Program Co-ordinator at the Department of Chemistry and Biochemistry, University of Windsor developed this study guide with the help of MMB Instructors including Dr. Micheal Boffa, Dr. Dante Capaldi, Dr. Anna Kozarova, and Dr. Pardeep Sidhu.

The unique and innovative Masters of Medical Biotechnology program brings together courses in biotechnology and business to provide students with a solid foundation for employment and entrepreneurship in the rapidly growing biotechnology sector. Biotechnology is a global industry that has given us novel protein and nucleic acid-based drugs as well as crucial innovations in agriculture, diagnostics, forensic science, and environmental remediation. It generates hundreds of billions of dollars of revenue annually and employs hundreds of thousands of people.



About the Program

On the biotechnology side of our program, we offer courses in drug discovery, protein structure and function, human physiology, cell biology of lipids, and clinical biochemistry. The MMB program has a four-month laboratory course in which the students will learn about and perform key state of the art techniques in biotechnology. On the business side, students can select from courses in International Business, Marketing, Leadership and Organizational Change. For more details, please visit the MMB website: <http://www.uwindsor.ca/science/chemistry/510/master-medical-biotechnology-mmb>



The MMB program takes place over four consecutive semesters and consists of ten courses:

- 2 Business Courses: Marketing, and Choose from International Business, or Leadership and Organizational Change
- 5 Science Courses: Drugs: from Discovery to Market; Biochemistry & Cell Biology of Lipids & Membranes; Clinical Biochemistry; Human Physiology and Mechanisms of Disease; Protein Structure and Function
- 1 Laboratory Course: Biotechnology Laboratory

- 2 Entrepreneurship Courses: Strategic Management of Biotech Innovations and Biotechnology Entrepreneurship

Contents of the Guide

Study guide has been developed keeping in mind the varied levels of understanding, and needs of International students. The aim is to prepare each and every International Student for a seamless transition to the MMB Program by providing the information about various courses and required resources for their success in the program. We hope that with the help of these resources, students will be ready to deliver at their best upon their arrival and after their arrival at the University of Windsor.

This study guide includes:

- Details and description of MMB Program courses,
- Resources and textbooks required/optional for these courses,
- Terminologies/Glossary frequently used in the courses, and
- Samples / Pre-Assessment Quizzes of various MMB courses.



BIOC-8740. Protein Structure and Function

Format: Lectures/ Labs

Assessment: Tests, Exams

Summary: This course will review and examine the principles of protein structure and how it applies to protein function. Moreover, how protein function is controlled and functional genomics will also be considered. Methodologies used in protein structure determination including mass spectrometry and its applications will be highlighted. The laboratory section of the course will focus on web based computational programs as they apply to protein structure and function.

Recommended Textbooks:

- Voet, Voet & Pratt. Fundamentals of Biochemistry, Life at the Molecular Level, 3rd edition.
- G. Petsko, D. Ringe. Protein Structure and Function.
- David W. Mount. Bioinformatics Sequence and Genome Analysis, 2nd edition. Cold Spring Harbor.
- David Whitford. Proteins Structure and Functions. HB Wiley.
- Branden, Carl, Tooze, John. Introduction to Protein Structure, 2nd edition. NY Garland Publishing.

BIOC-8730. Drugs: From Discovery to Market

Format: Lectures, Computer Labs

Assessment: Assignments, Presentations, Tests, Exams

Summary: The path of any new drug from its inception (design and discovery) to its approval in market and thereafter is a challenging task. This course will introduce students to the relevant concepts and chemical characterization that lead to the discovery and rational/irrational design of therapeutic agents. Students will learn from discussions on real life case studies in drug discovery and development which will not only foster self-learning but will also lay the foundation for the overall drug discovery to market process. In addition, the course will cover the fundamentals of the clinical trials process and best regulatory practices in pharmaceutical industries.

Recommended Textbooks:

- Graham L. Patrick. An Introduction to Medicinal Chemistry, 6th Edition. Oxford, UK: Oxford University Press (this is also the required textbook for the course).

- Rick Ng. *Drugs: From Discovery to Approval*, 2nd Edition. Hoboken, NJ: John Wiley & Sons, Inc.
- Riccardo Baron, Editor. *Computational Drug Discovery and Design*, E-Book. New York, NY: Humana Press, Springer.
- Hans Gerhard Vogel, Editor. *Drug Discovery and Evaluation: Pharmacological Assays*, E-Book. New York, NY: Springer.

BIOC-8760. Clinical Biochemistry

Format: Lectures

Assessment: Assignments, Presentations, Papers

This course will review and examine the principles of clinical biochemistry and will introduce the student to clinical testing, automation, clinical enzymology, and biomarkers. The course will also cover areas of design, testing, and commercialization of specific tests for liver function, abnormalities in lipid metabolism, thyroid diseases, diabetes and related metabolic disorders, fertility/reproduction, cancer, and therapeutic drug monitoring. This course will provide a broad overview of the current state of the technology for the analysis of clinical samples as well as learning the fundamental principles in design and testing of clinical assays for a wide range of analytes.

Recommended Textbook:

- *Clinical Biochemistry*, Nessar Ahmed, Ph.D., Oxford University Press, 2010.

BIOC-8720. Biochemistry and Cell Biology of Lipids and Membranes

Format: Lectures

Assessment: Papers, Presentations, Exams

Summary: This course focuses on the biochemistry and cell biology of lipids and their role in cellular signaling, with a particular emphasis on the experimental basis of current knowledge. Topics covered include lipid biochemistry, membrane biophysics, the biochemistry and metabolism of small molecules such as steroids and leukotrienes, and an integrative assessment of the role of lipids and membranes in cellular processes such as protein trafficking and intracellular signaling.

Recommended Textbooks:

- *Biochemistry: Life at the Molecular Level*, 4th edition by Voet & Voet.
- *Molecular Cell Biology*, 5th edition by Lodish et al.

- Lehninger Principles of Biochemistry, 4th edition, by Nelson & Cox
- Biochemistry of Lipids, Lipoproteins and Membranes, 5th edition by Vance and Vance

BIOC 8700. Human Physiology and Mechanisms of Disease

Format : Lectures, Online Discussions

Assessment: Assignments, Papers, Presentations, Tests, Exams

Summary: This course will cover the field of physiology as it relates to the further understanding, diagnostics, treatment, and human disease-mechanisms of disease. The course is taught from a holistic approach that provides key insights into cellular physiology and associated molecular aspects of biology related to human disease. The course will outline the principles and practice of cell and molecular physiology, pathological pathways, molecular pathogenesis, and molecular mechanisms of disease. It will be followed by investigations and discussion on the practice of molecular medicine and the translational aspects of molecular pathology: molecular diagnostics, molecular assessment, and personalized medicine. Students will be engaged in presentations and discussions of current and future industry trends, medical and research discoveries that are translational by enhancing the identification, diagnosis, and treatment of human diseases. Topics will include molecular and cellular mechanisms of cancer; inflammation and immunology; cell death and regulation; stem cell and developmental biology; neurobiology; and gene regulation.

Recommended Textbooks:

- Lauren Pecorino. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Oxford: Oxford University Press.
- Margaret A. Knowles, Peter J. Selby. Introduction to the Cellular and Molecular Biology of Cancer. Oxford Publisher Press.
- Bruce Alberts. Molecular Biology of the Cell. New York: Garland Science.
- John H. Wilson, Tim Hunt. Molecular Biology of the Cell: The Problems Book. New York: Garland Science.
- Derek W. Rosales, Quentin N. Mullen. Pluripotent Stem Cells. Hauppauge, NY: Nova Science Publishers.
- Jack A. Roth, Editor. Gene-based Therapies for Cancer. Electronic Resource. ISBN: 9781441961020. Springer.

BIOC-8790. Biotechnology Laboratory

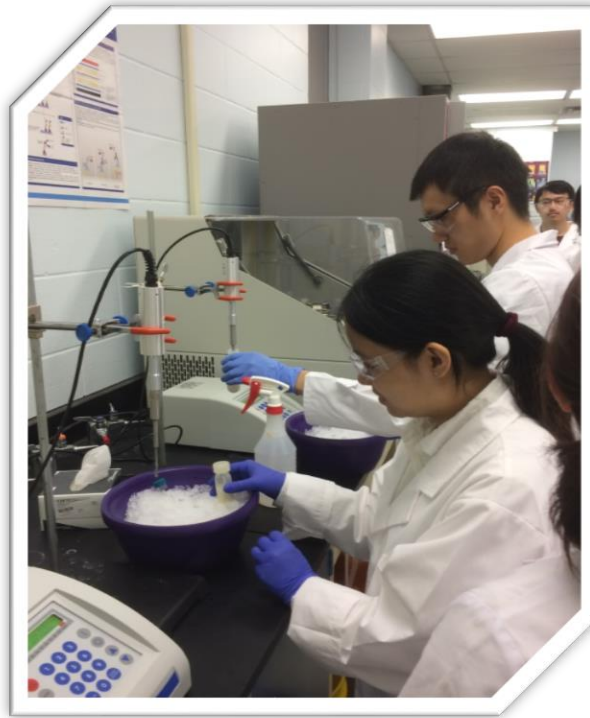
Format: Lectures, Laboratories

Assessment: Assignments, Lab Reports, Tests, Exams

This intensive hands-on laboratory course will primarily simulate the discovery and rapid characterization of genes and gene products (i.e. proteins). Laboratory experiments will include cutting edge biotechnology techniques and traditional biochemical methodology. Students will be introduced to techniques including nucleic acid isolation and amplification (i.e. PCR), regulation of gene expression, cloning, protein isolation and purification, enzyme functional assays and characterization (2-D electrophoresis, mass spectrometry).

Recommended Textbooks:

- Biotechnology by David P Clark and Nanette J. Pazdernik. Elsevier, c2016.
- Current protocols essential laboratory techniques. Sean R Gallagher; Emily A Wiley
- Guide to protein purification. Richard R Burgess; Murray P Deutscher.
- Culture of animal cells: a manual of basic technique. R. Freshney.
- Watson, Baker, Bell, Gann, Levine, Losick. Molecular Biology of the Gene 6th edition.



BIOC-8750. Strategic Management of Biotechnology Innovations

Format: Lectures, Discussions, Case Studies

Assessment: Assignments, Papers, Presentations, Exams

The course will provide an overview of the principles underlying the strategic management of innovation with a focus on the biotechnology sector. Topics will include: (i) Sources, types and patterns of innovation (ii) Timing of entry and approaches to improve timing options, (iii) Budget allocation for sustainable R&D projects, (iv) Collaboration strategies, (v) Ways to protect innovations, (vi) Managing new product development teams and (vii) Strategic launching of new products. The course will emphasize concepts and strategies necessary to the development of managerial skills and the appropriate knowledge to identify, evaluate, and manage new biotechnology-based innovations.

Suggested Books:

- Strategic Management of Technological Innovation, by Melissa Schillin, McGraw-Hill Education.

BIOC-8780. Biotechnology Entrepreneurship

Format: Lectures, Discussions, Case Studies

Assessment: Assignments, Papers, Presentations, Exams

Entrepreneurship in Biotechnology will provide students an introduction to the complexities and unique problems facing the biotechnology industry. Students will be exposed to the topics most critical for successfully founding, financing and operating a life science company, and will be expected to perform many of the same tasks that founders would normally undertake. Discussions with life-science entrepreneurs, evaluation of existing biotechnology firms, case studies based on recent companies and hands-on work developing entrepreneurial endeavors all will be utilized. (Equivalent to 2 courses.)

Recommended Textbook:

- Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Edited by Craig Shimasaki, Elsevier Inc.
- Damian Hine, John Kapeleris, Innovation and Entrepreneurship in Biotechnology, An International Perspective, Edward Elgar Publishing

BSMM-8310: International Business

Format: Lectures, Textbook, and short cases

Assessment: Exams, report and pitch

This course is designed to provide students with the tools to think globally and manage internationally. Technology advancement and globalization have created tremendous impacts on the environment for international business. A new set of skills and knowledge are required to conduct international business effectively in the constantly changing global environment. This course covers a wide range of topics including, the global trade and investment environment, the international firm's cultural, political, and competitive environment, and the management and operations of international firms. The focus throughout the course is on the changes that occur when a firm moves from a domestic focus to a global one.

Recommended Textbook:

- International Business Environments & Operations by Daniels, Radebaugh & Sullivan 15th ed. Pearson, ISBN: 9780133457230

Q1. Protein folding takes place mostly in the:

1. nucleus
2. endoplasmic reticulum
3. Golgi apparatus
4. cytosol

Q2. A mutation in a gene leading to a substitution of a serine for a threonine in a protein represents:

1. a nonsense mutation
2. a synonymous mutation
3. a conservative substitution
4. convergent evolution

Q3. The following two amino acids have positively charged side chains at neutral pH:

1. Lys and Arg
2. Glu and Asp
3. Gln and Asn
4. Trp and Gly

Q4. Knockout mice are created using:

1. homologous recombination
2. embryonic stem cells
3. blastocyst injection
4. all of the above

Q5. A tissue is homogenized, and is then extracted with chloroform. The organic phase contains:

1. most of the lipids
2. most of the proteins
3. most of the salt
4. most of the macromolecules

Q1. Which of the following binding interactions is likely to be the most important initial interaction when a drug enters a binding site?

1. van der Waals interactions
2. hydrogen bond
3. ionic
4. induced dipole-dipole interactions

Q2. Which of the following is one of the rules in Lipinski's rule of five?

1. a molecular weight equal to 500
2. no more than five hydrogen bond acceptor groups
3. no more than 10 hydrogen bond donor groups
4. a calculated logP value less than +5

Q3. What is the term used for drugs that are similar in structure to a known drug and which are used for the same purpose?

1. 'copycat' drugs
2. 'me-too' drugs
3. 'derivative' drugs
4. 'analogue' drugs

Q4. Natural products are often used as lead compounds in the design and synthesis of novel drugs. Which of the following general characteristics of a natural product is most likely to be a disadvantage in synthesizing analogues?

1. Novelty of structure
2. Complexity of structure
3. Level of activity
4. Availability

Q1. Describe an *in vitro* diagnostic medical device.

Q2. Explain the FDA 510(k) notification process for demonstrating “substantial equivalence”.

Q3. What is a standard operating procedure?

Q4. What is Point of Care Testing?

Q5. Name and describe the different endocrine tests used in diagnosing male and female infertility.



Dr. Michael Boffa and Dr. Tranum Kaur, Department of Chemistry & Biochemistry, University of Windsor presenting first place award to Jay Kumar Amrutia and Nitika at the MMB Bio Innovative Solutions (BIS) Competition.

Protein Structure and Function

- Allosteric
- Competitive Binding
- Cooperativity (positive and negative)
- Domain
- Primary/Secondary/ Tertiary/ Quaternary Structure
- Proximity
- Redox Environment
- Mass Spectroscopy
- Methylation/ N-Acetylation/Sumoylation/Nitrosylation/ Glycosylation
- Motif
- NMR
- Ramachandran plot
- Steric Interactions
- TIM Barrels
- Ubiquitination
- X-ray crystallography

. Biochemistry and Cell Biology of Lipids and Membranes

- Gradient
 - Electrical
 - Chemical
- Hydrophobic
- Hydrophilic
- Lipid
- Lipoprotein
- Permeability
- Signalling Cascade
- Viscosity (fluidity)

Drugs: From Discovery to Market

- Agonist
- Antagonist
- Adverse Events
- Biologics
- Biosimilar
- Efficacy
- ED50
- Fast Drug Approval
- Generic
- Half-Life
- High Throughput Screening
- LD50
- New Drug Application
- New Biologic License
- Orphan Drug
- Patent
- Potency
- QT Interval
- Small molecule drug
- Sensitization
- Tolerance

Human Physiology and Mechanisms of Disease

- Apoptosis
- Adenovirus
- Anti-angiogenesis therapy
- By-stander effect
- Caspases
- Clustered regularly interspaced short palindromic repeats (CRISPR)
- Cyclins and cyclin dependent kinases (cdk)

- Direct Reprogramming
- Death-inducing signaling complex (DISC)
- Fas-associated death domain (FADD)
- Gene Therapy (viral/ non-viral)
- Humoral Immunity
- Molecular chemotherapy/Suicide Gene Therapy
- Neurodegenerative diseases
- Oncofactor inhibition
- Pluripotency
- Pyknosis
- Prions
- Tumor immunotherapy

Clinical Biochemistry

- False Positive/Negative
- Quality Control
- Quality Assurance
- Organizational Chart
- Medical Device
- FDA
- Standard Operating Procedure
- Precision versus Accuracy
- ACTH: Adrenocorticotrophic Hormone
- ADH: Antidiuretic Hormone
- ALP: Alkaline Phosphatase
- ALT: Alanine Aminotransferase
- CK: Creatine Kinase
- CKD: Chronic Kidney Disease
- DDAVP: 1-Deamino, 8-D-Arginine Vasopression
- DIT: Diiodotyrosine
- DKA: Diabetic Ketoacidosis

- eGFR: Estimated Glomerular Filtration Rate
- FSH: Follicle Stimulating Hormone
- GFR: Glomerular Filtration Rate
- GTT: Glucose Tolerance Test
- hCG: Human Chorionic Gonadotrophin
- HDL: High Density Lipoprotein
- IDL: Intermediate Density Lipoprotein
- IGT: Impaired Glucose Tolerance
- INR: International Normalised Ratio
- LDH: Lactate Dehydrogenase
- LDL: Low Density Lipoprotein
- LH: Luteinising Hormone
- MIT: Monoiodotyrosine
- NAFLD: Nonalcoholic Fatty Liver Disease
- OGTT: Oral Glucose Tolerance Test
- PKU: Phenylketonuria
- POCT: Point of Care Testing
- PSA: Prostate Specific Antigen
- PT: Prothrombin Time
- ROC: Receiver Operating Characteristic
- T3: Triiodothyronine
- T4: Thyroxine
- TBG: Thyroxine Binding Globulin
- TRH: Thyrotrophin Releasing Hormone
- VLDL: Very Low Density Lipoprotein

Standing Required for Continuation in the Program and for Graduation

Students must have a cumulative average of not less than 70% to remain in good standing, and continue in the program.

MMB Rules and Regulations

MMB program follows rules and regulations of University of Windsor and Department of Chemistry and Biochemistry. Please see links below:

- Information about grading and academic evaluation procedures can be found in # [Senate Bylaw 55: Academic Evaluation Procedures for Graduate Students](#)
- # [Senate policy on Conduct of Exams and Tests](#)
- # [Senate Policy on Student Code of Conduct \(Academic Integrity\)](#)
- # [Senate Policy on Grading and Calculation of Averages](#)

Statement for students with disabilities

Students with disabilities who require academic accommodations in this course must contact an Advisor in Student Disability Services (SDS) to complete SDS Registration and receive the necessary Letters of Accommodation. After registering with Student Disability Services, you must present your Letter of Accommodation and discuss your needs with me as early in the term as possible. Please note that deadlines for the submission of documentation and completed forms to Student Disability Services are available on their website: www.uwindsor.ca/disability".

The University of Windsor, located in Windsor, Ontario, Canada is situated near the Detroit River only a four-hour drive from Toronto, Ontario, and six hours from Ottawa, the capital of Canada. For more details, you may visit **University of Windsor Virtual Tour:** <http://www.uwindsor.ca/174375/virtual-tour#virtualtour>.

Please check out a wonderful and free resource after you arrive here at the University of Windsor: **Your Guide to Succeed in University** (<http://www.succeedinuniversity.com/index.php/uoft-your-guide-to-success>)

Windsor is a small city that attracts large events, such as the FINA diving competition, as well as tourists and students from around the world. For more on the City of Windsor visit: **www.cityofwindsor.ca** or visit **windsorstar.com** to read our local newspaper.

As part of your admission conditions you may be required to write an English proficiency exam or English lessons, for information on ELIP visit: **www1.uwindsor.ca/celd** or for more information on requirements contact the Centre for Executive and Professional Education (CEPE) **www1.uwindsor.ca/cep**.

If you would like to be a part of the soft-landing program or have any questions about work or study permits contact the International Student Centre **www1.uwindsor.ca/isc**.

Conclusion

If you are feeling overwhelmed, remember that this guide covers courses worth of key concepts. The purpose is not to have you learn everything before you take the courses but to give you a chance to familiarize yourselves with the terminology, concepts, and textbooks. It is recommended that you take some time to practice reading peer-reviewed journal articles to enable you to keep up with the course readings. We hope that this guide will ease your transition into this program and would like to welcome you once more to the University of Windsor's Masters of Medical Biotechnology Program!

