

**Master of Science in Molecular Medicine**

**Semester 1/2**

**Molecular Basis of Diseases I**

**2 credits**

**Module Guide**

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| **TITLE: Molecular Basis of Diseases I** |  **COURSE CODE: MM322** |
| **LEVEL: SEMESTER 1/2** |  **PROGRAMME: MMMO** |

**CONTENT SYNOPSIS:**

This module examines the molecular basis of diseases with emphasis on neurodegenerative disorders, cardiovascular diseases, renal disorders, musculoskeletal disorders and reproductive disorders. This module also covers drug action and explores how cutting-edge biotechnology and biomedical research can advance pharmacological knowledge and to amplify the understanding of how drugs work.

This module focuses on molecular biology of diseases, which provides a multi-disciplinary approach for studying cell function and development with a basic understanding of genetics, signal transduction and the drugs that modulate cell signaling and cellular responses. The knowledge on molecular basis of the diseases and their pathology is important for the development of therapeutically effective agents, which could be used to tackle a disease.

The teaching and learning philosophy underpinning this course is based on student-centered learning as to encourage independent learning in students. This module will be delivered through a series of participatory lectures that are supported by in-depth discussion. The lectures provide instructions on designated topics while the discussion is an online learning environment moderated by lecturers as a platform for collaborative study between students. The teaching is both engaging and relevant in order to prepare students for their careers. Effective learning can be enhanced through self-directed use of other resources such as scientific journals and web-based resources.

**OBJECTIVES:**

The objectives of this module are to

1. Introduce various technical knowledge on the current methodologies and techniques employed in molecular basis of disease.
2. Instruct on the interaction between drugs and receptors.
3. Provide knowledge on basic and advanced molecular and cellular pathways that contribute to the occurrence and progression of diseases.
4. Present the current scientific and clinical evidence for pharmacological therapies.
5. Equip students with the ability to rationalizing patient-specific therapeutic approach.

**LEARNING OUTCOMES:**

At the completion of this course, the students will be able to:

1. Compare and evaluate the current techniques for advanced research in molecular basis of disease.
2. Evaluate the interaction between drugs and receptors; discuss the importance of molecular interactions that give rise to diseases and various adverse reactions and events.
3. Appraise the potentials and limitations of rationalizing patient-specific therapeutic approach in various human diseases and disorders.
4. Demonstrate competencies in evaluating scientific literatures and report presentation.

**LEARNING HOURS**

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| **Teaching modality** | **Guided Learning (F2F)** | **Guided Learning (NF2F)** | **Independent Learning** | **SLT** |
| **L** | **T** | **P** | **O** | **L** | **T** | **P** | **O** |
| Lecture |  |  |  |  | 7 |  |  |  | 14 | **21** |
| Discussion |  |  |  |  |  |  |  | 15 | 15 | **30** |
| Assignment 1: Scientific report  |  |  |  |  |  |  |  | 1 | 15 | **16** |
| Assignment 2: Seminar presentation |  |  |  |  |  |  |  | 3 | 10 | **13** |
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| **Total SLT** |  |  |  |  | **7** |  |  | **19** | **54** | **80** |

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| Note: F2F = Face-to face; NF2F = Non face-to-face; SLT = Student learning time; L = Lecture; T = Tutorial; P = Practical; O = Other activities**ASSESSMENTS** |
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In-course assessment

* Assignment 1 – Scientific report (3000-4000 words) 60%
* Assignment 2 – Seminar presentation 40%

**MODULE COORDINATOR:** Dr. Liew Yun Khoon (LYK)

**ASSOCIATED LECTURERS:** Assoc. ProfDr. Dinesh Kumar Chellappan (DKC), Dr. Hazwanie Hashim (HBH), Dr. Jestin Chellian (JCL)

**SYLLABUS:**

**1. Introduction to Molecular Basis of Diseases I** (Lecture 1 h)

This is a lecture outlining the basics of molecular diseases, including molecular biology, drug/receptor interactions, receptors and ion channels, regulation of second messengers, and drug metabolism. The correlation of genetics, basic physiology and pathology and its influence on molecular resistance, diagnostics, treatment and translational research will be dealt with.

**2. Functional Basis of Molecular Diseases** (Lecture 1 h)

The lecture deals with the knowledge regarding various molecular models of drug-receptor interactions, dose-response relationship, receptor theories including occupational theory, two state theory, ternary complexes and operational model of drug action. This will help students to understand the practicalities involved in the functional pharmacology which include different methods employed for measurement and comparison of drug response and various prerequisites for the acquisition of reliable data.

**3. Neurodegenerative Disorders** (Lecture 1 h; Online discussion 3 h)

The lecture will provide a focused overview of various neurodegenerative disorders such as Parkinson’s disease, Alzheimer’s disease, Huntington’s disease, amylotropic lateral sclerosis, prion disease; along with the various driving forces promoting research in this field. After the lecture, students will be provided with discussion topics of selected neurodegenerative disorders and discuss the basic physiology of the disorders, changes that occur at molecular levels including but not limited to genetics and pathophysiology. Moreover, the discussion should also cover the in vitro and in vivo models, biomarkers, mechanisms of molecular resistance, emerging trends in the treatment and recent diagnostics of the disorders.

**4. Molecular Basis of Renal Disorders** (Lecture-1 h; Online discussion 3 h)

The lecture will provide a focused overview of selected important renal disorders such as acute and chronic renal failure, glomerulonephritis, nephropathy, urinary tract infection, pyelonephritis, and obstructive kidney diseases including nephrolithiasis. The various enablers that promote the research in this field will be discussed. After the lecture, students will be provided with discussion topics of selected renal disorders and discuss the basic physiology of the disorders, changes that occur at molecular levels including but not limited to genetics and pathophysiology. Moreover, the discussion should also cover the in vitro and in vivo models, biomarkers, mechanisms of molecular resistance, emerging trends in the treatment and recent diagnostics of the disorders.

**5. Molecular Basis of Musculoskeletal Disorders** (Lecture 1 h; Online discussion 3 h)

The lecture will provide a focused overview of common musculoskeletal disorders such as rheumatoid arthritis, systemic lupus erythematous, progressive multiple sclerosis, Stevens-Johnson syndrome, osteoporosis, repetitive stress injury; along with the various enablers that promote research in this field. The discussion following the lecture will focus on examples of the musculoskeletal disorders where physiology and molecular changes (including genetic and pathophysiology), in vitro and in vivo models, biomarkers, as well as emerging trends in the diagnosis and treatment will be covered.

**6. Cardiovascular Diseases** (Lecture 1 h; Online discussion 3 h)

The lecture will provide a focused overview of selected important cardiovascular diseases such as hypertension, myocardial infarction, atherosclerosis, angina pectoris, heart failure, stroke, coronary heart diseases, along with the various enablers that promote research in this field. After the lecture, students will be provided with discussion topics of selected cardiovascular diseases and discuss the basic physiology of the diseases, changes that occur at molecular levels including but not limited to genetics and pathophysiology. Moreover, the discussion should also cover on, translational research, in vitro and in vivo models, biomarkers, molecular mechanisms, emerging trends in the treatment and recent diagnostics of the disorders.

**7. Molecular Basis of Reproductive Disorders** (Lecture 1 h; Online discussion 3 h)

The lecture will provide a focused overview of various reproductive disorders such as pelvic Inflammatory disease, menopause, female Infertility, endometriosis, sexually transmitted diseases, polycystic ovarian syndrome, male infertility, erectile dysfunction, testicular disorders; along with the various driving forces promoting research in this field. After the lecture, students will be provided with discussion topics of selected reproductive disorders and discuss the basic physiology of the disorders, changes that occur at molecular levels including but not limited to genetics and pathophysiology. Moreover, the discussion should also cover the in vitro and in vivo models, biomarkers, mechanisms of molecular resistance, emerging trends in the treatment and recent diagnostics of the disorders.

**READING LIST:**

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| Reference books: |
| 1. Eric J. Nestler, Steven Hyman, and Robert Malenka (2008) Molecular Neuropharmacology: A Foundation for Clinical Neuroscience, Second Edition, 2nd Edition, Mc Graw Hill Publishers.
2. Stefan Offermanns, Walter Rosenthal (2009) Encyclopedia of Molecular Pharmacology, Volume 1 and 2, 2nd Edition, Sringer.
3. Annette Gilchrist (2008) GPCR Molecular Pharmacology and Drug Targeting: Shifting Paradigms and New Directions, 1st Edition, Wiley.
4. Laurence L. Brunton, John S. Lazo and Keith L. Parker (2009), Goodman & Gilman's The Pharmacological Basis of Therapeutics, 12th Edition McGraw-Hill Professional.
5. Charles Wiener, Anthony S. Fauci, Eugene Braunwald, Dennis L. Kasper, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson, Joseph Loscalzo (2008), Harrison's Principles of Internal Medicine, Self-Assessment and Board Review, 17th Edition, Mc Graw Hill Publishers.
6. Joseph G. Cannon (2007), Pharmacology for chemists, 2nd Edition, Oxford University Press.
7. Fumagalli Guido, Clementi Francesco (Eds). General and Molecular Pharmacology: Principles of Drug Action. Hoboken, New Jersey: Wiley. 2015.
8. Gilchrist Annette (Ed). GPCR Molecular Pharmacology and Drug Targeting: Shifting Paradigms and New Directions. Hoboken, N.J: Wiley. 2010.
9. Lewis R (Ed). Human Genetics: Concepts and Applications, Ninth Edition McGraw−Hill. 2010.
10. John C. Foreman, Torben Johansen, Alasdair J. Gibb. (Eds). Textbook of receptor pharmacology, 3rd Edition. Boca Raton: CRC Press, 2011.
11. William B. Coleman, Gregory J. Tsongalis, Ch: 14, Molecular Basis of Cardiovascular Disease, In: Molecular Pathology: The Molecular Basis of Human Disease, 2009, 1st Edn., Academic Press, Elsevier, London, UK.
12. Dariush Mozaffarian, Jason HY Wu, Omega-3 Fatty Acids and Cardiovascular Disease: Effects on Risk Factors, Molecular Pathways, and Clinical Events, Journal of the American College of Cardiology, Vol 58, Issue 20, 8 November 2011, Pages 2047–2067.
13. Victor Garcia, Ankit Gilani, Brian Shkolnik, Varunkumar Pandey, Frank F Zhang, Rambabu Dakarapu, Shyam K Gandham, N R Reddy, Joan P Graves, Artiom Gruzdev, Darryl C Zeldin, Jorge H Capdevila, John R Falck, Michal L Schwartzman, 20-HETE Signals Through G Protein-Coupled Receptor GPR75 (Gq) to Affect Vascular Function and Trigger Hypertension, Circulation Research (2017) https://doi.org/10.1161/CIRCRESAHA.116.310525
14. Adam H.B. (2014), Intertility in practice, 4th Edition, CRC Press.
15. Merrill, R.M. (2010). Reproductive epidemiology : principles and methods, Sudbury, Mass. : Jones and Bartlett Publishers
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| Journals: |
| 1. Salahudeen, Mohammed Saji, Nishtala Prasad S. 2017. Review: An overview of pharmacodynamic modelling, ligand-binding approach and its application in clinical practice. Saudi Pharmaceutical Journal, February 25(2):165-175*.*
2. Gabor G. Kovacs (2016). Molecular Pathological Classification of Neurodegenerative Diseases: Turning towards Precision Medicine, International journal of molecular sciences, 17(189):1-33.
3. Masato Hasegawa (2016). Molecular Mechanisms in the Pathogenesis of Alzheimer’s disease and Tauopathies-Prion-Like Seeded Aggregation and Phosphorylation, Biomolecules 6(24):1-12.
4. Megha Agrawal, Abhijit Biswas (2015). Molecular diagnostics of neurodegenerative disorders, Frontiers in Molecular Biosciences, 2(54):1-10.
5. Masahisa Katsuno, Hirohisa Watanabe, Fumiaki Tanaka, Gen Sobue (2013). Translational research on disease-modifying therapies for neurodegenerative diseases, Neurology and Clinical Neuroscience, 1:3–10.
6. Vijay K Ramanan, Andrew J. Saykin (2013). Pathways to neurodegeneration: mechanistic insights from GWAS in Alzheimer’s disease, Parkinson’s disease, and related disorders, American Journal of Neurodegenerative Disease, 2(3):145-175.
7. Patrick Hickey, Mark Stacy (2011). Available and emerging treatments for Parkinson’s disease: a review, Drug Design, Development and Therapy, 5: 241–254.
8. Wyatt RJ, Julian BA. IgA nephropathy (2013). New England Journal of Medicine, 368(25):2402-14.
9. Loeffler I, Wolf G (2014). Transforming growth factor-β and the progression of renal disease. Nephrology Dialysis Transplantation, 29(suppl 1):i37-45
10. Sun YM, Su Y, Li J, Wang LF (2013). Recent advances in understanding the biochemical and molecular mechanism of diabetic nephropathy. Biochemical and biophysical research communications, 433(4):359-61.
11. Eddy AA (2014). Overview of the cellular and molecular basis of kidney fibrosis. Kidney international supplements, 4(1):2-8.
12. Ga-Young Ban, Seun-Joo Ahn, Hye-Soo Yoo , Hae-Sim Park and Young-Min Ye1 (2016). Stevens–Johnson Syndrome and Toxic Epidermal Necrolysis Associated with Acetaminophen Use during Viral Infections. Immune network, 16(4): 256-260.
13. Andrew S. Lee, Michael B. Ellman, Dongyao Yan , Jeffrey S. Kroin , Brian J. Cole , Andre J. van Wijnen, Hee-Jeong I (2013). A current review of molecular mechanisms regarding osteoarthritis and pain. Gene, 527: 440–447.
14. Jose U. Scher (2012). B-Cell Therapies for Rheumatoid Arthritis. Bulletin of the NYU Hospital for Joint Diseases, 70(3):200-3.
15. Christine Stadelmann (2011). Multiple sclerosis as a neurodegenerative disease: pathology, mechanisms and therapeutic implications. Current Opinion in Neurology, 24:224–229.
16. Jinliang Nan, Wei Zhu, MS Rahman, M Liu, Dan Li, Shengan Su, N Zhang, Xinyang Hu, Hong Yu, Mahesh P Gupta, J Wang, Molecular regulation of mitochondrial dynamics in cardiac disease, Biochimica et Biophysica Acta (BBA)- Molecular cell research, (2017) http://doi.org/10.1016/j.bbamcr.2017.03.006
17. Victor Garcia, Ankit Gilani, Brian Shkolnik, Varunkumar Pandey, Frank F Zhang, Rambabu Dakarapu, Shyam K Gandham, N R Reddy, Joan P Graves, Artiom Gruzdev, Darryl C Zeldin, Jorge H Capdevila, John R Falck, Michal L Schwartzman, 20-HETE Signals Through G Protein-Coupled Receptor GPR75 (Gq) to Affect Vascular Function and Trigger Hypertension, Circulation Research (2017) https://doi.org/10.1161/CIRCRESAHA.116.310525
18. Genetics of Congenital Heart Disease: The Glass Half Empty, Akl C. Fahed, Bruce D. Gelb, J. G. Seidman, Christine E. Seidman, Circulation Research, (2013) https://doi.org/10.1161/CIRCRESAHA.112.300853
19. Elsa Bronze-da-Rocha, “MicroRNAs Expression Profiles in Cardiovascular Diseases,” BioMed Research International, vol. 2014, Article ID 985408, 23 pages, 2014. doi:10.1155/2014/985408
20. Zhang, Y., et al., (2016). Metformin Ameliorates Uterine Defects in a Rat Model of Polycystic Ovary Syndrome, EBioMedicine, http://dx.doi.org/10.1016/j.ebiom.2017.03.023.
21. Conde-Ferraez, L., Martiez, J.R., Ayora-Talavera and Losa, M.D. (2017). Human papillomavirus and Chlamydia trachomatis infection in gyneco-obstetric outpatients from a mexican hospital. Indian J Med Microbiol., 35(1), 74-79. doi: 10.4103/ijmm.IJMM\_15\_450.
22. Mengmeng, X., Long C., Zhenguo Y. et al. (2017). Proteomic Analysis of Fetal Ovaries Reveals That Primordial Follicle Formation and Transition Are Differentially Regulated. BioMed Research International, doi:10.1155/2017/6972030.
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