MGY 350 Syllabus – Winter 2026
Monday and Wednesday at 3-4:30PM
Room: WB 219 (Monday), MS 2173 (Wednesday)

Date	Topics	Lecture #	Readings	Prof
Jan 5	**Introduction to stem cells-based models.** a. Different types of stem cells. b. Pluripotent stem cells, reprogramming. c. Differentiation in 2D and 3D, organoids.	1	**Reviews on reprogramming and organoids (optional reading):** **(1)** A decade of transcription factor-mediated reprogramming to pluripotency. Takahashi and Yamanaka (2016) **Nat Rev Mol Cell Biol**, 17(3):183-193. PMID: 26883003 **(2)** Studying human neurodevelopment and diseases using 3D brain organoids. Tian et al (2020) **J Neurosci**, 40(6): 1186-1193. PMID: 32024767	YL
Jan 7	**Discussion group:** Induced pluripotent stem cells, brain organoids.	2	**Papers for discussion:** **(1)** Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. Takahashi and Yamanaka (2006) **Cell**, 126(4):663-676. PMID: 16904174 **(2)** Cerebral organoids model human brain development and microcephaly. Lancaster et al (2013) **Nature**, 501(7467): 373-379. PMID: 23995685	YL
Jan 12	**Studying brain diseases using human stem cells and organoids** a. Overview of brain diseases b. 2D models c. 3D organoid models	3	**Review on disease modeling (optional reading):** **(1)** Stem cells, genome editing, and the path to translational medicine. Soldner and Jaenisch (2018) **Cell**, 175(3): 615-632. PMID: 30340033	YL
Jan 14	**Discussion group:** Fragile X disease modeling, CRISPR epigenetic editing.	4	**Papers for discussion:** **(1)** Rescue of fragile X syndrome neurons by DNA methylation editing of the FMR1 gene. Liu et al (2018) **Cell**, 172(5):979-992. PMID: 29456084 **(2)** A human forebrain organoid model of fragile X syndrome exhibits altered neurogenesis and highlights new treatment strategies. Kang et al (2021) **Nature Neuroscience**, 24(10): 1377-1391. PMID: 34413513	YL

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Jan 19	**Applying human cellular models for translational research** a. CRISPR screens b. Drug screens	5	**Review on iPSC-based screens (optional reading):** **(1)** CRISPR-based functional genomics for neurological disease. Kampmann (2020) **Nat Rev Neurol**, 16(9): 465-480. PMID: 32641861 **(2)** Drug screening for human genetic diseases using iPSC models. Elitt et al (2018) **Hum Mol Genet**, 27(R2): R89-R98. PMID: 29771306	YL
Jan 21	**Discussion group:** CRISPR screens for brain disease research.	6	**Papers for discussion:** **(1)** Genome-wide CRISPR screen for Zika virus resistance in human neural cells. Li et al (2019) **PNAS**, 116(19): 9527-9532. PMID: 31019072 **(2)** Single-cell brain organoid screening identifies developmental defects in autism. Li et al (2023) **Nature**, 621(7978): 373-380. PMID: 37704762	YL
Jan 26	**Snow Closure**		No class	
Jan 28	**Zebrafish genetics and biology** a. Utility of zebrafish as a model system b. Forward genetic strategies c. Reverse genetic tools d. Confounders, mitigating strategies, and resources	7	**Review papers (optional reading):** **(1)** Animal models of human disease: zebrafish swim into view. Lieschke and Currie, 2007. **Nature Reviews Genetics**, 8(5):353-67. PMID: 17440532 **(2)** Loss-of-function genetic tools for animal models: cross-species and cross-platform differences. Housden et al. 2017. **Nature Reviews Genetics**, 18(1): 24-40. PMID: 27795562	BC

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Feb 2	**Discussion group:** zebrafish genetics and biology	8	**Papers for Discussion:** **(1)** Positional cloning identifies zebrafish one eyed pinhead as a permissive EGF-related ligand required during gastrulation. Zhang et al. 1998. **Cell**, 92(2):241-51. PMID: 9458048 **(2)** Genetically encoded affinity reagents are a toolkit for visualizing and manipulating endogenous protein function in vivo. Boswell et al. 2025. **Nature Communications,** 16(1):5503. PMID: 40595661	BC
Feb 4	**Applying zebrafish models to understand disease.** Case studies in: a. Idiopathic scoliosis b. Congenital scoliosis	9	**Review papers (optional reading):** **(1)** Understanding Idiopathic Scoliosis: A New Zebrafish School of Thought. Boswell et al. 2017. **Trends in Genetics**, 33(3):183-196. PMID: 28174019 **(2)** Development of a straight vertebrate body axis. Bagnat et al. 2020.**Development**, 147(21): dev175794. PMID: 33023886	BC
Feb 9	**Discussion group:** Zebrafish genetic models of human disease	10	**Papers for Discussion:** **(1)** Cilia-driven cerebrospinal fluid flow directs expression of urotensin neuropeptides to straighten the vertebrate body axis. Zhang et al. 2018. **Nature Genetics**, 50(12):1666-1673. PMID: 30420648 **(2)** SCO-spondin defects and neuroinflammation are conserved mechanisms driving spinal deformity across genetic models of idiopathic scoliosis. Rose et al. 2020. **Current Biology**, 30(12):2363-2373. PMID: 32386528	BC
Feb 11	**Advancements in zebrafish developmental genetics:** a. Modeling complex disease b. Identifying modifier genes c. Chemical suppressor screens d. Precision medicine	11	**Review papers (optional reading):** **(1)** Zebrafish as tools for drug discovery. MacRae et al. 2015. **Nature Reviews Drug Discovery,** 14(10):721-31. PMID: 26361349 **(2)** Zebrafish patient avatars in cancer biology and precision cancer therapy. Fazio et al. 2020. **Nature Reviews Cancer**, 20(5):263-273. PMID: 32251397	BC

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Feb 16	**Family Day/Reading Week**		No class	
Feb 18	**Family Day/Reading Week**		No class	
Feb 23	**Midterm exam (Dr. Li's section only)**	12		YL
Feb 25	**Discussion group:** Recent advances in zebrafish disease modelling	13	**Papers for Discussion:** **(1)** Visualizing engrafted human cancer and therapy responses in immunodeficient zebrafish. Yan et al. 2019. **Cell**, 177(7):1903-1914. PMID: 31031007 **(2)** DNA damage response deficiency enhances neuroblastoma progression and sensitivity to combination PARP and ATR inhibition. Hayes et al. 2025. **Cell Reports**, 44(4):115537. PMID: 40220294.	BC
Mar 2	**Animal models to study heart development and the origins of congenital heart disease** a) Overview of comparative (sea squirt, fly, fish, mammalian), heart development b) Discovery of cardiac transcription factors and their functions defining cardiac cell lineages c) Contribution of major progenitor cell lineages to heart formation	14	**Review papers (optional reading)** **(1)** Coordination of cardiogenesis in vivo and in vitro. Medhan et al. 2025. **Nat Rev Mol Cell Biol,** PMID: 40993223 **(2)** Harnessing developmental cues for cardiomyocyte production. Mass et al. 2023. **Development,** 150(15): dev201483. PMID: 37560977 **(3)** Discovery and progress of direct cardiac reprogramming. Kojima and Ieda. 2017 **Cell Mol Life Sci,** 74:2203-2215. PMID: 28197667	PDO
Mar 4	**Discussion group:** Recent discoveries in heart development model research	15	**Papers for discussion** 1) MEF2 controls segment-specific gene regulatory networks that direct heart tube morphogenesis. Muncie-Vasic et al. 2025. **Genes Dev,** 39(23-24): 1451-1467. PMID: 40883017 2) CHD4 is recruited by GATA4 and NKX2-5 to repress noncardiac gene programs in the developing heart. Robbe et al. 2022. **Genes Dev,** 36: 468-482. PMID: 35450884	PDO

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Mar 9	**Emerging heart development in vitro models** a) Cardiac organoids b) Engineered heart tissues c) Bioengineering platforms	16	**Review papers (optional reading)** **(1)** Generation and applications of cardiac spheroids. Idais et al. 2025. **npj Biomedical Innovations,** 2(17). PMID: 42032307 **(2)** Advances in cardiac tissue engineering and heart-on-a-chip. Kieda et al. 2023. **J Biomed Mater Res A,** 112(4):492-511. PMID: 37909362	PDO
Mar 11	**Discussion group:** Insights from *in vitro* modeling of heart disease	17	**Papers for discussion** 1) Modeling acute myocardial infarction and cardiac fibrosis using human induced pluripotent stem cell-derived multi-cellular heart organoids. Song et al. 2024. **Cell Death & Disease,** 15(5): 308. PMID: 38693114 2) Geometrically controlled cardiac microtissues promote vascularization and reduce inflammation in vitro and in vivo. Zhao et al. 2025. **Cell Biomaterials,** 1(4): 100075. PMID: 40771434	PDO
Mar 16	**Animal models used to study cardiac regeneration and repair** a) Zebrafish, the igniter of the heart regeneration field b) Transient regeneration of the newborn mouse heart c) Leveraging cardiogenic transcription factors in cardiac repair	18	**Review papers (optional reading)** **(1)** Building and re-building the heart by cardiomyocyte proliferation. Foglia and Poss. 2016. **Development,** 143(5): 729-740. PMID: 26932668 **(2)** Revitalizing the heart: Strategies and tools for cardiomyocyte regeneration post-myocardial infarction. Bois et al. 2025. **npj Regen Med,** 10(1): 6. PMID: 39843488	PDO
Mar 18	**Discussion group:** Emerging strategies for cardiac repair	19	**Papers for discussion** 1) Cross-species comparison reveals that Hmga1 reduces H3K27me3 levels to promote cardiomyocyte proliferation and cardiac regeneration. Bouwman et al. 2025. **Nat Cardiovasc Res,** 4(1): 64-82. PMID: 39747457 2) The PD-1-PD-L1 pathway maintains an immunosuppressive environment essential for neonatal heart regeneration. Vargas Aguilar et al. 2024. **Nat Cardiovasc Res,** 3(3): 389-402. PMID: 38737787	PDO

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Date	Topics	Lecture #	Readings	Prof
Mar 23	**Free day**		No class	
Mar 25	**Guest Lecture by Dr. Miguel Ramalho-Santos**	20		MRS
Mar 30	**Review for final exam**	21		BC + PDO

Mid-term exam:	30%
Discussion group attendance and participation*:	10%
Final exam:	60%
Total	100%

*For discussion group classes, **attendance is mandatory**. Students will be divided into groups of 4-5 to present specific figures/tables assigned by the professor at the beginning of each class.