Zebrafish Neurodevelopment Laboratory

NEUR 406: Fall 2023

Instructor: Dr. Gwendolyn (Wendy) Lewis
Instructor e-mail: glewis13@gmu.edu
Course Time: Thursday 1:30am – 4:10pm
Course Location: Krasnow 259
Credits: 3
Instructor Office: Krasnow 254
Office Hours: Drop-in office hours are held during the times below. If you are unable to attend a drop-in time, please email me to schedule an appointment.

- **Monday/Wednesday/Friday 1pm-2pm.** Log in virtually https://gmu.zoom.us/j/4952912681 or come in person to Krasnow 254.
    - If multiple students need to meet at once, in-person visitors will get priority. I'll meet with students in the Zoom room in the order they entered. Please be patient if you are in the Zoom waiting room!

Course Overview

Zebrafish (*Danio rerio*) are a powerful model system used in neuroscience, biology and pharmacology research. This is primarily because zebrafish embryos are optically transparent and develop externally, which means that developmental processes can be directly visualized and manipulated beginning at the one-cell stage! Zebrafish are also vertebrates, and their nervous system has more in common with humans than you might think. In this laboratory, you will use zebrafish as a model system to study vertebrate nervous system development. You will learn basic techniques for manipulating, imaging, and analyzing zebrafish embryos, while performing experiments to investigate the structure and function of the nervous system in healthy and diseased states. You will work with other students to design and carry out a novel scholarly research project.

Mason Impact + Research and Scholarship

This course is designated as a Mason Impact + Research and Scholarship course. This means you will "engage in the process of generating and sharing undergraduate research". As part of the course, you will design, execute, and present a research project relating to neurodevelopment in zebrafish. Your completed project can be submitted for a special transcript designation displaying the title of your project, and you may present your project at one of Mason's symposiums.

Research and Scholarship Learning Goals

During this course you will work in small groups to design, execute, and present an original research project. Each group's project will be different and will make important contributions to our knowledge of nervous system development. Research and scholarship related learning goals and the course activities that support them are listed below.

Learning Goals	Activities
Articulate and refine a question, problem, or challenge	• Project proposal
Distinguish between personal beliefs and evidence	• Project proposal

Learning Goals	Activities
	• Lab reports
Identify relevant ethical issues and follow ethical principles	• Lab reports • Lectures/discussions
Choose an appropriate research method for scholarly inquiry	• Project proposal • Investigation of live imaging, morphology, and locomotor behavior • Free project work
Gather and evaluate evidence appropriate to the inquiry	• Investigation of live imaging, morphology, and locomotor behavior • Immunohistochemistry • Free project work
Appropriately analyze scholarly evidence	• Investigation of live imaging, morphology, and locomotor behavior • Immunohistochemistry • Free project work • Project presentations • Lab reports
Explain how scholarly inquiry has value to society	• Project presentations • Lab reports • Lectures/discussions
Explain how knowledge is situated and shared in relevant scholarly contexts	• Lectures/discussions
Take responsibility for creating and executing an original scholarly or creative project	• Project proposal • Project meetings • Investigation of live imaging, morphology, and locomotor behavior • Immunohistochemistry • Free project work
Communicate knowledge from an original scholarly or creative project	• Project presentations • Project write-up

Course Specific Learning Goals:

By the end of this course, you should be able to...

- Compare and contrast the organization of the nervous system in zebrafish and humans
- Describe the advantages and disadvantages of zebrafish as a model system
- Describe common experimental techniques used in zebrafish research
- Perform basic zebrafish manipulations, including staging embryos, dechorionating, removing unfertilized embryos, and exchanging media
- Anesthetize zebrafish embryos and perform live imaging
- Analyze embryo morphology and locomotor behavior
- Explain the concept of immunohistochemistry and use this technique to analyze neurons and glia in whole-mount embryos
- Analyze data using appropriate statistics
- Explain how alcohol and other drugs affect nervous system development at the molecular, cellular, and morphological level
- Diagram and explain the development of the zebrafish nervous system
- Develop a research question, design an experiment, collect data, carry out analyses and interpret results

- Effectively present your research in written and oral format

Opportunities to Present Research

Students will have the opportunity to present their research projects within and outside of Mason. These opportunities will be discussed in class and assistance will be provided in preparing applications and abstracts. Opportunities include: The Society for Neuroscience Annual Meeting, the Mid-Atlantic Society for Developmental Biology Annual Meeting, the COS Undergraduate Research Colloquium, the OSCAR Celebration of Student Scholarship, and more.

Text and Readings

There is no required text. All readings/activities will be provided and posted on Blackboard.

Supplies

- Lab notebook (cheap composition book is fine). You can keep a digital notebook, but I must receive a printed copy at the end of the semester.

Grading and Assessments:

Lab Notebook	10%
Participation	15%
Lab Reports/Assignments/Quizzes	40%
Research Project (Proposal, Oral, Poster)	35%
Total Grade	**100%**

Grading Scale:
Final weighted grades in Blackboard are rounded to the nearest whole number.
A+ = 98-100%, A = 90-97%, B+ = 88-89%, B = 80-87%, C+ = 78-79%, C = 70-77%, D = 60-69%, F = 0-59%

Assignment Details:

Lab Notebook: You will maintain a lab notebook according to guidelines provided by the instructor. Someone unfamiliar with the lab procedures should be able to look at your lab notebook and replicate the procedures that you conducted during class. Details about what should be included in lab notebooks will be provided on a weekly basis. Lab notebooks will be checked at the start of each class and graded at the end of the semester.

Participation: Your grade in this course will include a participation score ranging from 0 – 5 points per class meeting. A score of 5 points will be given to a student who reports to lab on time, is prepared by having completed the readings ahead of time, is properly dressed, and actively participates in all lab activities and class discussions. A score below 5 points will be given to a student who does not fully demonstrate 100% effort in a given lab session. This could include things like arriving late, being unprepared, inappropriate phone usage during class, not having done the readings, not actively participating in lab activities and discussions, disrupting other students, failing to cooperate, leaving lab before all the work (including cleaning) is done, etc. If you are unable to attend due to illness, email the professor before the start of class for alternative assignments.

Lab Reports/Assignments/Quizzes: You will complete written lab reports to assess your knowledge of classroom activities. Some reports may include statistical analysis that require you to use Mason's computer labs. Other reports will include the objective of the experiment, the hypothesis tested, reporting of results, and conclusions regarding the results. Before attending lab each week, you will usually need to 1) read the weekly research paper, and 2) read the weekly lab activity. You will take pre-lab quizzes on that material in Blackboard.

Research Project: You will work in small groups to design, conduct, and present an original research project using zebrafish embryos and the techniques covered in class. You and your group will work together on this project throughout the semester. Your group will give an oral presentation of your findings and will report results in written format in lab reports throughout the semester. Detailed information about this project will be distributed in class. The research project will include a 1) proposal, 2) final oral presentation, and 3) poster, all of which will receive a group grade. Peer feedback will be solicited at multiple points throughout the semester.

Attendance, Illness and Late Work Policy

You are expected to attend class and participate in all discussions and activities. Attendance is an integral part of this course, and absences will result in significant missed information. Unexcused absences will result in a loss of participation points for the day and the inability to complete your lab notebook entries and lab reports. Excused absences can only be obtained in cases of illness or emergency. ***If you are sick, please do not attend lab!*** Contact me and your group before class if you will be unable to attend lab. There are no make-up labs available, but alternative work may be assigned for excused absences. Late work will incur a penalty of 20% and may be turned in up to 2 weeks after the deadline.

Communication

E-mail is generally the best way to contact me. When you e-mail, please do so **from your university e-mail account only**. **Include the course name in the subject line and your name in the e-mail**. I will not respond to emails from outside accounts. Check your e-mail and course Blackboard account daily and before each class meeting. I will use e-mail and Blackboard to communicate with you regarding changes related to the course, syllabus, and other essential information. You are responsible for all announcements posted and sent via Blackboard and e-mail, in addition to announcement make in class.

Student Conduct Policies

Be kind and respectful to your classmates, Disruptive, disrespectful, or rude behavior will lead to dismissal from class and will count as an absence for the day. You will also miss out on all the cool things we do in lab!

Cell phones in the lab: Please silence phones during class. Cell phone use/ringing (other than for emergency) during class may result in deduction of points from the course participation grade.

Computers in the lab: Computers will only be allowed in the lab during specified times.

Laboratory Dress: You **must wear long pants and closed toed shoes** in the laboratory. If you are improperly dressed, you will not be allowed into the lab.

Food and Drink: There is absolutely **no food or drink** allowed in the lab.

Academic Integrity

Honesty and integrity are issues at the very core of this course and of science as a whole. George Mason has an honor code with clear guidelines for academic integrity. A few of the most important rules that pertain to this course are: 1) All work submitted must be your own should be done individually unless explicitly stated otherwise. You will be encouraged to discuss ideas, collaborate, and brainstorm with your classmates, but actual assignments need to be completed individually. You may not use papers from students who have previously taken the class to help you with your assignments. 2) When referencing the work of others (this includes published and non-published work or ideas), full credit must be given through appropriate citations. 3) If you are ever unsure about the rules for an assignment, ask for clarification. Cheating and plagiarism of any form is not tolerated. Plagiarism means using the exact words, opinions, or information from another person without giving the appropriate credit. Per the Office of Academic Integrity, "subcategories of plagiarism include:

- Self-plagiarism: Intentionally or unintentionally using portions of one's old work for new assignments without appropriate attribution and/or advanced permission from the current course instructor
- Failure to adequately quote and/or cite sources or material
- False citation: This includes but is not limited to referencing work that does not appear in the indicated source."

Sharing of instructor-created materials, particularly materials relevant to assignments or exams, to public online "study" sites is considered a violation of Mason's Honor Code. For more information, see the Office of Academic Integrity's summary of information about online study sites.

Any offense will be referred to the academic integrity office and be dealt with in accordance with university regulations. Get more information about the Office of Academic Integrity here: https://oai.gmu.edu/. Get more information about plagiarism here https://oai.gmu.edu/mason-honor-code/what-is-plagiarism/ and tips for avoiding it here https://writingcenter.gmu.edu/writing-resources/citing-sources/plagiarism.

In the event that an assignment permits the use of Generative-AI tools, usage must follow the fundamental principles of the Honor Code. This includes being honest about the use of these tools for submitted work and including citations when using the work of others, whether individual people or Generative-AI tools.

AI Text Generators: AI Text generators will not be allowed for the majority of work in this course. In most cases, usage of generative AI will contradict the learning goals of this course. However, there may be specific instances where generative AI is allowed for a specified purpose. In these cases, when explicitly stated by the instructor, Generative AI tools are allowed on the named assignment. Use of these tools on any assignment not specified will be considered a violation of the academic integrity policy. All academic integrity violations will be reported to the office of Academic Integrity. Work produced with the aid of Generative AI is not without risk. If generative AI is used, you will be responsible for any incorrect, biased, or unethical information that is submitted, and you must be transparent with your use. A statement-of-usage is always required when using generative AI. Citations for source material are always required whether using generative AI or not.

Disability Accommodations

If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Office of Disability Services (SUB I, Rm. 4205; 993-2474; http://ods.gmu.edu) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

Mason Diversity Statement*

George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

** This is an abbreviated statement, full statement is available at http://ctfe.gmu.edu/professional-development/mason-diversity-statement/*

Student Services

- Learning Services (learningservices.gmu.edu/keeplearning/)
- University Libraries (library.gmu.edu)
- Writing Center (writingcenter.gmu.edu)
- Counseling and Psychological Services (caps.gmu.edu)
- See a longer list of Mason student support services posted on The Stearns Center website.

Add/Drop Deadlines

Deadlines for the Fall 2022 semester can be found on the Mason Academic Calendar page.

All policies may be modified on an individual basis at the discretion of the instructor.

Course Calendar

NEUR 406-001, Fall 2023

Date	Topic	Lab Activities	Pre-Lab Activities and Assignments Due *Due 1 hour before class via Blackboard unless noted*
Week 1 Aug 24	Introduction to Zebrafish	• Introduction to zebrafish • Laboratory safety and zoonosis • Introduce projects • Field trip to Krasnow	
Week 2 Aug 31	Staging and Development	• Temperature experiment • Staging exercise • Discuss project design and assignments	Pre-Lab Activities • Read Kimmel at al., 1995 **pages 253-260** • Read Lab Guide: Staging and Development • Read Research Project Overview • Read Lab Notebook Guidelines • **Take Pre-Lab Quiz** Assignments Due • **Zebrafish CITI training** (submit completion reports to Blackboard)
Week 3 Sept 7	Live Imaging	• Microscopes, anesthesia, and live imaging • Dechorionation, anatomy • Discuss project ideas with group and professor	Pre-Lab Activities • Read Rieger et al., 2011 • Read Lab Guide: Live Imaging • **Take Pre-Lab Quiz** • Brainstorm project ideas with group Assignments Due • **Staging Lab Report**
Week 4 Sept 14	Morphology Scoring	• Score morphology of embryos • Assign literature review	Pre-Lab Activities • Read Panzica-Kelly et al. 2010 • Read Lab Guide: Morphology Scoring • **Take Pre-Lab Quiz**

Date	Topic	Lab Activities	Pre-Lab Activities and Assignments Due *Due 1 hour before class via Blackboard unless noted*
			• Choose project chemical/treatment before class Assignments Due • **Live Imaging Lab Report Due**
Week 5 Sept 21	Locomotor Development	• Analyze spontaneous tail coiling and touch-evoked responses • Build the locomotor circuit in Crescent Loom • Assign Project Proposals • Discuss Experimental Design	Pre-Lab Activities • Read Downes and Granato, 2006 • Read Lab Guide: Locomotor Analysis • **Take Pre-Lab Quiz** Assignments Due • **Literature Review Due by 12:30pm on 9/22**
Week 6 Sept 28	Data Analysis and Graphing **Virtual Lab- use posted videos to work on during lab time**	• Watch Lecture: From Raw Data to Figures • Complete SPSS Tutorial • Complete Image J Tutorial • Take Virtual Lab Quiz	Pre-Lab Activities • Download SPSS and ImageJ- make sure you can open programs Assignments Due • **Virtual Lab Quiz Due by 11:59pm on 9/22** • **Morphology and Data Analysis Lab Report Due**
Week 7 Oct 5	Solutions and Dilutions	• Pipetting, solutions, dilutions, experimental setup • Discuss project proposals and setup with professor	Pre-Lab Activities • Read Pipetting and Solutions Lab Guide • Sign up for Krasnow Lab Tour for Week 8 (as a group) Assignments Due • **Locomotor Lab Report Due**
Week 8 Oct 12	**Lab Tour and Project set up (during sign-up time)**	• Tour Krasnow lab during assigned time • Make project solutions	Pre-Lab Activities • Project Set-Up Worksheet Assignments Due • **Project Proposals Due (group assignment)**

Date	Topic	Lab Activities	Pre-Lab Activities and Assignments Due *Due 1 hour before class via Blackboard unless noted*
			• Bring Project Set-up Worksheet to lab tour
Week 9 Oct 19	Project Work I	• Project Data Collection (Live Imaging, Morphology and/or Locomotor Analysis)	Pre-Lab Activities • **Set up project in Krasnow Lab**
Week 10 Oct 26	Project Work II	• Project Data Collection (Live Imaging, Morphology and/or Locomotor Analysis)	Pre-Lab Activities • **Set up project in Krasnow Lab** Assignments Due • SPSS data file with week 1 data (group)
Week 11 Nov 2	Project Work III	• Project Data Collection (Live Imaging, Morphology and/or Locomotor Analysis) • Fix embryos for IHC	Pre-Lab Activities • **Set up project in Krasnow Lab**
Week 12 Nov 9	Immunohistochemistry (IHC) I	• Day 1 IHC on project embryos	Pre-Lab Activities • Read IHC Lab Guide Assignments Due • **Project Work Lab Report (individual) and SPSS file (group) Due**
Week 13 Nov 16	Immunohistochemistry (IHC) II	• Imaging and analysis of IHC • Poster Feedback • Work on Presentations	Pre-Lab Activities • Finish Day 2 and 3 of IHC in Krasnow **237** lab Assignments Due • **Poster draft (group) due** • **Immunohistochemistry Lab Report Due**
Week 14 Nov 23	**Thanksgiving Break**	**No Class!**	
Week 15 Nov 30	Project Presentations and Research Celebration	• Oral presentations of projects	Due Thursday before class • **PowerPoint slides due to Blackboard before class (group)** Due Friday by 11:59pm

Date	Topic	Lab Activities	**Pre-Lab Activities and Assignments Due** *Due 1 hour before class via Blackboard unless noted*
			• **All data files (SPSS and images) (group)** • **Final Poster (group)** • **Self and peer evaluation (individual)** • **Submit Project Title to Mason Impact!** https://provost.gmu.edu/initiatives/mason-impact/mason-impact-students Due Monday by 9am • **Lab Notebook**

NOTE: This schedule is subject to change at any time. **You are responsible for all announcements and syllabus modifications made in class each week whether you are present or not.**

Project work is in blue.