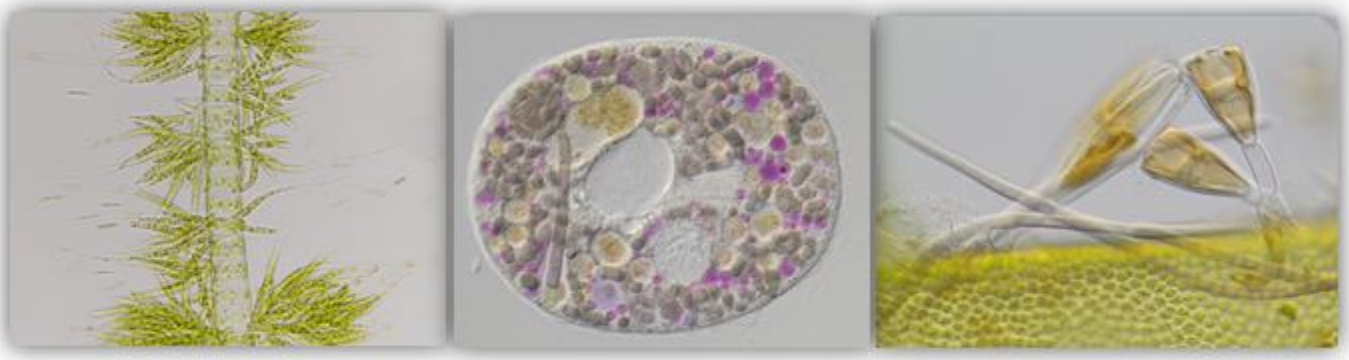


PROTIST DIVERSITY AND ECOLOGY
EVPP/BIOL 441, EVPP 505

Lecture Syllabus, Spring 2024

Course Content:

Our examination of this material will include lectures in-person, selected readings, and laboratory exercises. The laboratory is a required component of this class.

Mode of instruction

Lectures in person: Mon/Wed, 3:00 – 4:15 pm, Main Campus Research Hall 202
Labs in person: Fri, 10:30 am – 1:15 pm, Potomac Science Center L005
Lecture power point presentations will be posted to our course webs site (Blackboard) every Monday at 10 am for review prior to the lectures in-person.
Course Web Site: Go to http://mymason.gmu.edu, log in with your netID (this is your email name without @gmu.edu) and your GMU email password. All information for the lectures will be posted here weekly.

Lecture Instructor

Dr. Rosalina Christova
Assistant Professor, Environmental Science and Policy
Office: 2102 Potomac Science Center
Office hours: Friday 1:30 – 3:30 pm and by appointment
Email: rchris13@gmu.edu
Phone: (703) 993-1048

Communication

Student drop-in hours: Friday 1:30 – 3:30 pm, Office 2102 PSC
Please email me first if you want to set up an individual or Zoom meeting.

Office hours are your opportunity to meet with me one-on-one (and with others, if you like) and ask questions about the course - or anything else. We can talk about campus resources, majors and minors, recommendation letters, writing your CV, your future plans, or we can just have a chat, a cup of tea, and a bite of comfort food.

Emails are the main mode of communication. I'll try to answer emails within 24 hours (except for the weekends), IF you include EVPP/BIOL 411/505 in the subject line.

Students must use their Mason email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address.

Confidentiality is important to all of us, so I will protect your privacy. P**lease contact me in advance if you cannot attend a lecture or lab, or you need extended time for your assignments** or have any other difficulties. I understand that life happens and some days are harder than others. Please take care of yourselves, and reach out for support if you need it. I would like to know how you are doing and to help if you need it. If you tell me that you are having trouble, I am not going to judge you or think less of you. I hope you will extend me the same grace.

- If you need specific accommodations for test taking or other issues, visit https://ds.gmu.edu/.
- See the **GMU Policies and Student Support Resources** section at the end of this syllabus for details.
- If you need extra help, miss class, or more time with assignments, just ask. ***I promise I will work with you.***

Course Description and Goals

This course is designed to examine the diversity and ecology of photosynthetic and non-photosynthetic eukaryotic protists and cyanobacteria (precursors to protists) primarily distributed in freshwater and marine habitats. The evolution and phylogeny of these related, but relatively distinct organismal groups are highlighted. An ecological perspective is used to explore the diversity and ecological significance of algae which are the main primary producers in aquatic ecosystems and heterotrophic protozoa which play an important role as consumers in microbial food webs. Biotechnological applications of protists such as their potential as energy sources and as building materials is explored as well economic and health concerns caused by harmful and nuisance algal blooms and protozoan parasites are discussed. The laboratory provides students with hands on exercises to sample, view and identify protists as well as experience in laboratory and field methods used by aquatic ecologists to sample and study protists.

Prerequisites: EVPP 210 or BIOL 213; EVPP 301 or BIOL 300

Course Learning Outcomes

- Knowledge of algal and protozoan diversity and ecology
- Understanding of how the major groupings of protists are differentiated and the major evolutionary steps that led to such a diversity
- Current concepts in protist systematics, ecological adaptations and reproductive strategies
- Ability to discuss the basic characteristics of photosynthetic cells and the role of single and multiple endo-symbioses in major algal lines
- In-depth appreciation of ecological roles of protists in aquatic ecosystems.
- Consideration of importance and functional role of autotrophic algae and heterotrophic protozoa in aquatic ecosystems and food webs.
- Examine and be able to recognize representative common members of each major group of algae and protozoa, including cyanobacteria, both freshwater and marine
- Learn current field and laboratory methods for collecting and identifying benthic and planktonic algae and protozoa
- Learn how to measure some aspects of protist activity and growth in the lab and in the field.

Course Culture, Roles and Responsibilities

Scientists collaborate to learn, ask questions, and explain phenomena. The classroom culture is designed to engage you in thinking like an environmental scientist. This means cooperative learning and problem solving will be emphasized. The most important aspect of this class, and being a scientist, involves how you show up and contribute in a respectful and collaborative way in all your scientific pursuits. You will self-assess your efforts as a community member throughout this class, and your activities as a community member will be evidenced in your performance in the class.

As facilitator I will encourage and create a learning environment in which **all** students are **actively** engaged in the process of scientific thought and reasoning. I would like to create a learning community that supports a **diversity** of thoughts, perspectives and experiences, and honors your identities (including race, gender, class, sexuality, religion, ability, etc.). To help accomplish this, if you have a name and/or set of pronouns that differ from those that appear in your official records, please let me know. I shall guide your development toward **higher-order thinking and reasoning** skills so you can successfully explore and demonstrate achievement of each of the goals above. My responsibility is to present course concepts and to facilitate your understanding of them, so please ask questions in class and feel free to stop by during office hours or contact us with any questions that are not adequately addressed in class or in our materials. We will work together to find the best solution to support your success in our class.

How to Be Successful in This Course

• Attend every lecture and lab in person. **If you cannot attend a lab class, please let us know in advance.**
• Access the **Course Web Site** and GMU email daily.
• Get familiar with weekly postings and due dates.
• Take good notes and pictures during the lectures.
• Complete exams, assignments and a final presentation.
• Devote at least 4 additional hours per week for these learning activities.
• Computer, web and other problems will happen! No worries, inform me in a timely manner and we will figure it out!
• **Late Work and Missed Classes.** We all know scholars have responsibilities to their education, on top of their commitments to family, other loved ones, and jobs. In fact, being a scholar is just like having a job. You have to show up on time, stay for your entire shift, do your work, and turn it in by due dates. However, we also know that sometimes one responsibility becomes more important than another, and our plans go awry. **If you have a family, medical, legal, or immigration-related emergency, please let me know so I can support an alternate plan for you to meet your responsibilities to your small group, our class, and yourself**.
• Late work will be subject of **10% deduction** of the grade if not communicated with the instructor in advance.
• If the campus closes, or if a class meeting needs to be canceled or adjusted due to weather or other concern, students should check Blackboard for updates on how to continue learning and for information about any changes to events or assignments.

Course Topics and Schedule

This topic sequence is approximate and may change.
All assignments will be posted **on Blackboard Wednesdays at 1:00 pm** and **due following Wednesday at 1:00 pm.**

Week	Date	Lecture Topic	Reading	Activity
1	1/17	Why we study protists? Defining Protists. Protist habitats and ecology. Their ecological importance. Their role in altering the composition of the atmosphere and lithosphere. Their use in products such as concrete, drugs, vaccines, lubricants, fertilizer, cosmetics, dentistry, soil treatments, and foods. Harmful algal blooms.	Lee 2018, Chapter I	
2	1/22	Protist phylogeny and relationships. Biological classification and species concepts. Vertical vs. horizontal gene transfer. Molecular phylogenetic approaches and applications. Endosymbiosis and the diversification of eukaryotic algae. Origins of algal plastids.	Lee 2018, Chapter II Archibald et al. 2020, Chapter "Protist Diversity and Eukaryote Phylogeny"	
	1/24	**Cyanobacteria I** – "The toxic harmful blooms producers" Prokaryotic cell structure. Cyanobacteria as precursors of protists. Morphology, diversity, reproduction, distribution and ecology. Extreme habitats. Nitrogen fixation, toxin and odor production. Cyanobacterial symbioses. Fossil record.	Lee 2018, Chapter II	
3	1/29	Overview of major protist groups. Their morphology, reproductive approaches and life cycles, pigmentation, photosynthesis, nutrition in non-photosynthetic protists, and life cycles. Mixotrophy. Protists and biochemistry.	Lee 2018, Chapter III/3	Quiz 1
	1/31	**Cyanobacteria II** – "The toxic harmful blooms producers" Cyanobacterial toxic harmful blooms (planktonic and benthic: overview, distribution, importance, monitoring and management.) • ***Invited speaker Dr. Mike Paul, EPA***	ITRC 2020 (https://hcb-1.itrcweb.org/) ITRC 2022 (https://hcb-1.itrcweb.org/)	
4	2/5	**Red Algae (Rhodophyta)** – "The marine red carpet" Morphology, diversity, distribution and ecology. Life cycles. Ecological importance in benthic marine communities. Applications: biotechnology, food industry, mariculture. Fossil record.	Lee 2018, Chapter III/4	
	2/7	**Green Algae I:** "The Precursors to Plants" Ulvophyceae, Treboxiophyceae, Chlorophyceans (including Volvocales, Oedogoniales, Chaetophorales). Morphology, diversity, distribution, reproduction and ecology. Importance in aquatic ecosystems. Applications: biotechnology, food industry, aquaculture.	Lee 2018, Chapter III/5	Quiz 2
5	2/12	**Green Algae II:** "The Precursors to Plants" Streptophytes: Zygnematophyceae, Coleochaetophyceae, Charaphyceae Morphology, diversity, distribution, reproduction and ecology. Importance in aquatic ecosystems.	Lee 2018, Chapter III/5	
	2/14			**Exam 1**
6	2/19	**Euglenoids** – "The swimmers in polluted ponds" Morphology, life history, diversity, distribution and ecology. Applications: nuisance and toxic blooms.	Lee 2018, Chapter IV/6	
	2/21	**Dinoflagellates** – "The toxic red tides producers" Photosynthetic Alveolates: relationships and life histories. Dinoflagellates: morphology,	Lee 2018, Chapter IV/7	

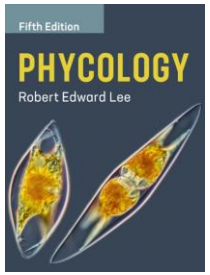
		diversity, distribution and ecology. Applications: toxic marine red tides blooms, freshwater nuisance blooms		
7	2/26	**Cryptomonads** – "The swimmers in lakes" Relationships and life histories. Morphology, diversity, distribution and ecology. Applications: Mixotrophy, kleptoplastidy, ejectosomes.	Lee 2018, Chapter IV/9	
	2/28	**Chrysophyceans, Synurophyceans, Eustigmatophyceans, Dictyochophyceans Xanthophyceans** – "The golden microalgae with one hairy flagellum" Relationships and life histories. Morphology, diversity, distribution and ecology. Applications: Mixotrophy. Nuisance blooms. Fossil record.	Lee 2018, Chapters V/10, V/11, V/12, V/14, V19	Quiz 3
8	**3/6**	**Spring Break**		
9	**3/11**			**Exam 2**
	3/13	**Diatoms (Bacillariophyta)** – "The golden unicells enclosed within a silica box" Relationships and life histories. Morphology, diversity, distribution and ecology. Applications: importance in food webs, toxic marine blooms (*Pseudo-nitzschia*). Fossil record.	Lee 2018, Chapters V/17	
10	**3/18**	**Haptophytes** (Haptophyta/Prymnesiophyta) – "The calcifying plated unicells and their toxic freshwater relatives" Relationships and life histories. Morphology, diversity, distribution and ecology. Applications: carbon sequestration. Toxin producers (*Prymnesium*). Cryptic species. Fossil record.	Lee 2018, Chapters V/22	**Presentations**
	3/20	**Brown Algae (Phaeophyta)** – "The marine brown giants" Photosynthetic Stramenopiles III: cellular and flagellar features. Morphology, diversity, distribution and ecology. Life cycles. Ecological importance in benthic marine communities. Applications: biotechnology, food industry, mariculture.	Lee 2018, Chapters V/21	Quiz 4
11	3/25	**The Protozoa - "The heterotrophic Protists"** **Ciliates (Ciliophora)** – "The hairy protozoa". Morphology, diversity, distribution, reproduction and ecology. Importance in aquatic ecosystems.	Lynn 2007	
	3/27	**Amoebozoans: "The Blobby Protists"** Lobose amoebae (naked and testate), Rhizarians, Radiolarians, Foraminiferans, Plasmodial slime molds, Cellular slime molds - morphology, life cycle, ecology and habitats.	Archibald et al. 2020, Chapters: "Amoebozoan Lobose Amoebae, Myxomycetes Dictyostelia"	
12	4/1	**Heterotrophic Flagellates, Non-photosynthetic Excavates:** *Trypanosoma*, *Naegleria*, *Giardia*: parasites on humans. **Non-photosynthetic Alveolates:** Apicoplexans: parasites on humans and animals (e.g., *Plasmodium, Toxoplasma, Cryptosporidium*). **Non-photosynthetic fungus-like Stramenopiles**: structure, diversity, distribution and ecology. Applications: parasites on plants and aquatic organisms.	Archibald et al. 2020, Chapter: "Apicoplexa", "Kinetoplastea", "Polycystinea", "Stycholonche", "Hyphochytriomycota and Oomycota", "Labyrinthulomycota"	
	4/3	**Phytoplankton Ecology** Response to physical and chemical environment. Productivity and food chain contributions. Growth and loss processes. Competition. Grazing. • ***Invited Speaker Dr. Brittani Hupp, GMU***	Reynolds 2006 Wehr et al. 2015, Chapter 2	Quiz 5
13	4/8	**Periphyton Ecology** Response to physical and chemical factors. Productivity and food chain contributions. Growth and grazing. Lakes vs. streams.	Wehr et al. 2015, Chapter 2	
	4/10	Non-photosynthetic protists in aquatic food webs: microbial loop. Mixotrophy.	Esteban and Fenchel 2020, Chapters 4,	

			7-10	
14	4/15	Protists in symbioses: lichens, corals, zooxanthellae, zoochlorellae, nitrogen-fixing cyanobacterial endosymbionts in diatoms. Importance of symbioses in terrestrial, freshwater and marine ecosystems.	Lee 2018, Chapter II	
	4/17	Harmful, nuisance and invasive eukaryotic algae. Distribution, ecological and economic importance. Impact of climate change on harmful algae. Example: "Rock Snot" diatom *Didymosphenia*.	Wehr et al. 2015, Chapter 20 https://dwr.virginia.gov/fishing/didymo/	
15	4/22	Role of algae and cyanobacteria in sedimentary rock formation (stromatolites, diatomite, chalk from coccolithophores, coralline rock, lime secreting algae). Production of fossil fuels, and global Carbon cycling. Protists in building materials (algae as substitute for concrete). Use of algae in biotechnology, food and pharmaceutical industries, aquaculture.	Lee 2018, Chapters I, V/23 https://time.com/6192603/algae-plant-buildings-carbon	
	4/24			**Presentations**
FINAL EXAM (Finals Week)				

Required Textbooks

Lee, R., 2018. Phycology (5th ed.). Cambridge: Cambridge University Press (available at GMU bookstore, two copies available from the instructor)

Archibald, J. M. et al., 2020. Handbook of the Protists. Springer (Free download available)



Methods of Evaluation

You will receive combined lecture and lab grade. The laboratory report and participation in the laboratory will count 100 pts.

● **Exams (200 points total)**

For the lecture, there will be two mid-term exams (50 points each) and a final exam that will have two parts: 50 pts for material since the 2nd midterm and 50 pts on the whole lecture content (100 points total). The exams will have multiple choice questions, true-false questions and a cumulative essay question which allow you to demonstrate your creative thinking about subject matter in this course. Examples will be presented in lecture and posted on Blackboard. Review sessions will be held before each exam. All exams are closed book. The exams will need to be completed in the available time. All graded materials are subject to the GMU Honor Code and violations must be reported to the Honor Committee.

● **Class activity (50 points total)**

There will be five quizzes during the semester for a total of 25 points (5 points each). Lectures will finish with review questions to help you learn the material. Lectures will start with discussion of previous questions and quizzes. You will receive additional bonus points for active class participation as part of discussions during the lectures. The maximum bonus points per student are 25.

● **Lead journal article discussion for all students (50 points)**

A brief 20 minutes presentation is required on any topic of your choosing related to one of more of the lectures. Please use this opportunity to research and present additional information about the fascinating organism or fact you discovered in this course to the class. This presentation will be given during the lectures

● **Lead journal article discussion for graduate students (50 points)**

A brief paper is required consisting of a total of approximately 2500 words (4 pg single spaced) on any topic of your choosing related to one of more of the lectures.

The presentation and paper will pull together information from online sources on an environmental issue involving protists (algae or protozoa) or cyanobacteria and published online. Guidelines will be forthcoming as a separate document. Example publications are provided next: "Didymo (Invasive Freshwater Algae) in Virginia" (https://dwr.virginia.gov/fishing/didymo/); "2021 Cyanobacteria Bloom and Recreational Advisory for the North Fork Shenandoah River, Virginia, USA" (https://www.youtube.com/watch?v=5N-YZon1a_k); PEREC Gunston Cove Ecosystem Study https://perec.science.gmu.edu/our-research/gunston-cove-study/

Graded Items	Points
1. Term exams (2 x 50 points each)	100
2. Final exam	100
3. Class activity	50
4. Presentation	50
5. Paper (graduate students only)	50
6. Lab	100
Total Points	**400 (450)**

Your final grade will be a letter grade, while your grades in class will be scores (between 0 and 100). In general, your final grade will be translated to a letter grade at the end of the semester as follows:
(Please note that if you make any grade less than C, the course may not count for certain requirements.)

100-98%	A+	89-88%	B+	79-78%	C+	69-60%	D
97-92%	A	87-82%	B	77-72%	C	<60%	F
91-90%	A-	81-80%	B-	71-70%	C-		

References (* indicates free download available):

*Archibald, J. M., Simpson, A.G.B., Slamovits, C.H., Margulis, L., Melkonian, M., Chapman, D. J., Corliss, J. O., 2020. Handbook of the Protists. Springer. https://link.springer.com/referencework/10.1007/978-3-319-32669-6

*Esteban, G.F. and T.M. Fenchel, 2020. The Ecology of Free-living Protozoa. 2nd Ed. Springer. file:///C:/Users/rcjones/Downloads/978-3-030-59979-9.pdf

*ITRC (Interstate Technology & Regulatory Council). 2020. Strategies for Preventing and Managing Harmful Cyanobacterial Blooms (HCB-1). Washington, D.C.: Interstate Technology & Regulatory Council, HCB Team, https://hcb-1.itrcweb.org/

*ITRC (Interstate Technology & Regulatory Council). 2022. Strategies for Preventing and Managing Harmful Benthic Cyanobacterial Blooms (HCB-2). Washington, D.C.: Interstate Technology & Regulatory Council, HCB Team, https://hcb-2.itrcweb.org/

Lee, R., 2018. Phycology (5th ed.). Cambridge: Cambridge University Press. doi:10.1017/9781316407219

*Lynn, D. H., 2007. The Ciliated Protozoa. Characterization, Classification and Guide to the Literature. 3rd Ed. Springer. file:///C:/Users/rcjones/Downloads/978-1-4020-8239-9.pdf

Reynolds, C.S. 2006. The Ecology of Phytoplankton. Cambridge University Press. https://doi.org/10.1017/CBO9780511542145

Wehr, J.D., Sheath, R.G. & Kociolek, J.P. (eds.) 2015. Freshwater algae of North America. Ecology and classification. Elsevier Academic Press, Amsterdam. 873–905 pp.

*Yeager, R. G., 1996. Protozoa: Structure, Classification, Growth, and Development. Chapter 77 in: Medical Microbiology. 4th Ed. https://www.ncbi.nlm.nih.gov/books/NBK8325/ (Chapters 78-85 contain more detailed descriptions of specific disease-causing protists.)

GMU Policies and Student Support Resources

Honor Code: Adherence to the GMU Honor Code is expected of all students (https://oai.gmu.edu/full-honor-code-document/)

- *The integrity of the University community is affected by the individual choices made by each of us. As a Mason student, you should follow these fundamental principles at all times, as noted by the Honor Code: (1) All work submitted should be your own, without the use inappropriate assistance or resources, as defined by the assignment or faculty member; (2) When you use the work, the words, the images, or the ideas of others–including fellow students, online sites or tools, or your own prior creations–you must give full credit through accurate citations; (3) In creating your work, you should not take materials you are not authorized to use, or falsely represent ideas or processes regarding your work. If you are uncertain about the ground rules or ethical expectations regarding the integrity of your work on a particular assignment or exam, you should ask your instructor for clarification. Support for you to complete your work is available; no grade is important enough to justify academic misconduct.*
- *As in many classes, a number of projects in this class are designed to be completed within your study group. With collaborative work, names of all the participants should appear on the work. Collaborative projects may be divided up so that individual group members complete portions of the whole, provided that group members take sufficient steps to ensure that the pieces conceptually fit together in the end product. Other projects are designed to be undertaken independently. In the latter case, you may discuss your ideas with others and conference with peers on drafts of the work; however, it is not appropriate to give your paper to someone else to revise. You are responsible for making certain that there is no question that the work you hand in is your own, and that you follow the expectations of the Honor Code. If only your name appears on an assignment, your professor has the right to expect that you have done the work yourself, fully and independently.*
- *Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and*

violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification

Disability Accommodations: Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities.

- *Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:ods@gmu.edu | Phone: (703) 993-2474*
- *Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:ods@gmu.edu | Phone: (703) 993-2474*

Diversity and Inclusion: 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.

- *We seek to create a learning environment that fosters respect for people across identities. We welcome and value individuals and their differences, including gender expression and identity, race, economic status, sex, sexuality, ethnicity, national origin, first language, religion, age and ability. We encourage all members of the learning environment to engage with the material personally, but to also be open to exploring and learning from experiences different than their own.*

Sexual Harassment, Sexual Misconduct, and Interpersonal Violence

Notice of mandatory reporting of sexual or interpersonal misconduct: *As a faculty member, I am designated as a "Non-Confidential Employee," and must report all disclosures of sexual assault, sexual harassment, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-993-3686 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance or support measures from Mason's Title IX Coordinator by calling 703-993-8730, or emailing titleix@gmu.edu.*

Student Support Resources on Campus:

The Stearns Center for Teaching and Learning offers great resources supporting student success, such as

- Student Support and Advocacy Center (SSAC)
- Counseling and Psychological Services
- The Learning Services Office or field-specific tutoring
- The Center for Culture, Equity, and Empowerment
- LBGTQ+ Resources
- University Career Services
- University Writing Center

For full list visit https://stearnscenter.gmu.edu/knowledge-center/knowing-mason-students/student-support-resources-on-campus/ and https://wellbeing.gmu.edu/students/.