Zoology 604: Computer-based gene and disease/disorder research lab
2 credits (spring term)
https://canvas.wisc.edu/courses/91189

Course Designations & Attributes:
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement

Meeting time and location: Tuesday: 1:20-4:40 p.m. Van Hise 250

Instructional Mode: all face-to-face

Credit hours: Traditional; direct classroom 200 minutes per week (50 min x 4 = 2 lab credits). At least two hours per week of out of class work is expected for each student.

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Course Description:
In recent years, a large number of open access biological and biomedical databases have become available for on-line, computer based research. Among these databases are the National Center for Biotechnology Information, Allen Brain Atlas, NIH DAVID, Genemania, ToppClusterPhenopedia, GeneNetwork, GWAS Central, and Broad Institute's MSIgDB. Within these and other sites is a wealth of information regarding genes, gene expression, gene pathways, behavioral characteristics, and disorders or diseases, such as autism, arthritis, bipolar disorder, and schizophrenia. Learning to navigate the various sites to take advantage of the information and push scientific discovery forward is a valuable skill to develop for any student interested in a career in science or medicine. In the early part of this laboratory course, students will be guided through a range of databases and shown how to extract information to develop new ideas. A key part of the course is that each student will pick a disease or disorder

of interest (e.g., autism, arthritis, epilepsy, schizophrenia) and use multiple databases to develop new ideas on which genes may be playing important, but previously underappreciated or unknown roles.

Requisites: Biology/Zoology 101 or Biology/Botany/Zoology 151 or Biocore 381

Course Learning Outcomes:
In this course students will:

1) Learn to navigate through a range of open access biological and biomedical databases databases and extract information to develop new ideas on how genes are linked to diseases, disorders, or traits.

Within these sites is a wealth of information regarding genes, gene expression, gene pathways, behavioral characteristics, and disorders or diseases, such as autism, arthritis, bipolar disorder, and schizophrenia. Learning to navigate the various sites to take advantage of the information and push scientific discovery forward is a valuable skill to develop for any student interested in a career in science or medicine. A key part of the course is that each student will pick a disease or disorder of interest (e.g., autism, arthritis, epilepsy, schizophrenia) and use multiple databases to develop new ideas on which genes may be playing important, but previously underappreciated or unknown roles. Alternatively, the student could focus on a gene of interest to understand how it intersects other genes and/or with different disorders.

2) Learn how to combine knowledge from existing publications with that obtained using on-line database research to advance an understanding of how genes and diseases/disorders are linked.

3) Learn to create a novel hypothesis about how genes may be linked to a disorder or disease.

An important part of research is learning how to generate a new idea of how complex things work together.

4) Learn how to synthesize novel findings in the form of class presentation and final paper.

5) Learn how to work cooperatively by contributing to research performed by classmates.

Grading:

Final grade: 28% = homework assignments; 50% = final research paper; 12% = oral presentation of final paper; 10% = class participation, effort.

Homework: 28 points
Final research paper: 50 points
Oral presentation: 12 points
Class participation/effort: 10 points
Total = 100 points

Letter Grades:
92-100% = A; 88-91% = AB; 82-87% = B; 78-81% = BC; 70-77% = C; 60-69% = D; 0-59% = F

If a graduate student takes the course, then the level of performance is evaluated at a graduate level. For example, for the final paper, it is expected that the level of depth for the research topic is at the level expected to be published by a graduate student in a peer review standard journal. Depth of understanding is expected to be high throughout the paper and citations should include primary literature articles at a level that indicate a scholarly approach to reading the background literature. The potential next steps of the research described in the paper would also be expected to reflect a Ph.D. level of understanding and would be equivalent to a grad level grant application. The presentation is expected to be at a professional meeting level and will be graded accordingly.

Laboratory sessions:
Each lab involves demonstrations of how to use the online tools and during the lab the students use the tools as they conduct research.

Example Class Schedule:

1/23: Introduction to computer based research and discussion of individual interests
1/30: introduction to National Center for Biotechnology Information (NCBI) and disease specific databases; enrichment tools, including Topp Cluster, GATHER, …NIH DAVID, GO, and others; introduction to GeneMania, Gene Weaver, GeneCards, and Gene within NCBI
2/6: GeneNetwork (WebQTL) and the linking of chromosome loci, traits, and gene expression; use of gene lists from on-line databases and publications; introduction to the gene expression omnibus (GEO) and conducting analysis using GEO2R; students begin thinking about projects; gene pathways, and different methods for linking disorders to genes and gene expression, including Modular Single-set Enrichment Test (MSET)
2/13: MSET uses; KEGG; STRING; UCSC Genome browser; refresher on the uses of PubMed, Web of Science, and Google Scholar; Allen Brain Atlas and the linking of brain regions to gene expression
2/20: Additional ways to analyze data from GEO datasets; Gene Set Enrichment Analysis (GSEA); navigating transcription factor databases; Gemma; group discussions
2/27: Machine Learning (using Weka). Discussion of paper format for final report; GWAS Central; interactive session with class on projects; reports from students on new tools/resources
3/6: Informal reports from students on projects; brain storming session to help with roadblocks; GWASdb2; revisiting WebQTL
3/13: Continue projects
3/20: Voluntary student presentations on new tools or approaches
3/27: Spring break
4/3: Continue projects
4/10: Tutorial on bringing together data and developing hypotheses; discussion of papers and presentations; sign up for presentations begins; continue projects
4/17: Synthesis of findings and preparation for presentations
4/24: Formal presentations
5/1: Formal presentations

Required textbooks, software & other course materials:
No formal textbook will be used. All on-line tools are open access. All software, including R and Weka (for machine learning) are open access. Additional optional readings may include:

Grisham W, et al (2010) Teaching bioinformatics and neuroinformatics by using free web-based tools. CBE--Life Sciences Education 9: 98-107

Andreux PA et al (2012) Systems genetics of metabolism: the use of the BXD murine reference panel for multiscalar integration of traits. Cell 150:1287-1299

Talishinsky A, Rosen GD (2012) Systems genetics of the lateral septal nucleus in mouse: heritability, genetic control, and covariation with behavioral and morphological traits. PLoS One 7(8): e44236

Barrett T, et. al. (2013). NCBI GEO: archive for functional genomics data sets--update. Nucleic Acids Res. 2013 Jan;41(Database issue):D991-5

Sunkin SM et al (2013) Nucleic Acids Res. 2013 Allen Brain Atlas: an integrated spatio-temporal portal for exploring the central nervous system. Jan;41(Database issue):D996-D1008.

Systematic and integrative analysis of large gene lists using DAVID Bioinformatics Resources. (2009) Nat Protoc. 4(1):44 -57.

Gene set enrichment analysis: GSEA user guide (2012) Broad Institute.

Exams, Quizzes, Papers, & other major graded work:

Research structure: Each student is responsible for his/her own research project and is graded individually. However, students are encouraged to have a research partner or partners with whom they share their findings throughout the semester and gain feedback. By having research partners and being the partner for others, the students will gain additional insights from one another and share in the enthusiasm of discovery. During a portion of some classes, students will be asked to work in groups of 2-3 to update others on progress and get feedback.

Presentation: Classroom presentations (e.g., via PowerPoint) of the research should be 10 minutes long and there will be 2 min for questions at the end. Students should have an introduction that provides a background of the study performed. Please remember that this a general audience, so one should assume they know little of the genes or disorders you will be discussing and plan to provide sufficient details for them to follow your logic. For results, focus on the key results and how you got there. It is much better to highlight key findings (make your graphs and lettering fill the slide) than to show everything and have the audience get confused. You can put additional results in the paper, but here you want to make your main points from your findings. For your discussion, focus on interpretations of data and where this might lead you next. If someone else in the class played a key role in helping you down a successful track of research, you should acknowledge that insight in the talk.

Final Paper: Final Paper will be ~12 pages long, including references. Paper will include: Abstract; Title, Introduction, Methods, Results, Discussion, and Figures and/or Tables. More details on preparing papers will be provided during the course.

Homework & other assignments:

Students will complete four homework assignments. Due dates will be provided during the semester. Students will start the first homework assignment during the second week. Details on each homework will be provided when it is assigned. Homework reports can be submitted

Canvas. Please send the report as an attachment in pdf format and include your name in the document title. Note that each homework will lose 2 points per day that it is late.

RULES, RIGHTS & RESPONSIBILITIES

- See the Guide's to Rules, Rights and Responsibilities

ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to studentconduct.wiscweb.wisc.edu/academic-integrity/.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

DIVERSITY & INCLUSION

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world." https://diversity.wisc.edu/