MOLECULAR BIOLOGY & BIOCHEMISTRY
ABOUT THE MAJOR

ACADEMIC YEAR 2023/2024

WESLEYAN.EDU/MBB

Wesleyan University

Contents

INTRODUCTION

The MB&B Department

The MB&B department was founded in 1984 to ride the revolution in molecular life sciences occurring at the time. At present the department comprises 10 faculty members who specialize in different research areas, over 70 majors, and 16 Ph.D. and BA/MA students.

Research in the department utilizes advanced molecular approaches to explore the structure, function and interplay of biological molecules such as proteins and nucleic acids. Strong extramural funding and the Ph.D. program afford our undergraduates research opportunities unparalleled amongst our peer institutions. Many majors spend one or more summers doing full time research at Wesleyan (as part of the Research In Science program run by the College of Integrative Science), engage in a Senior Honors thesis, or participate in our five-year BA/MA program (tuition-free fifth year). It is not uncommon for our majors to co-author publications in major scientific journals with their faculty mentors. Most of our students go on to complete professional degrees, and they are competitive at the highest level for admission into graduate and professional programs at prestigious universities such as Harvard, Yale, Columbia, Princeton, Stanford, Duke, and Johns Hopkins University.

The Molecular Biology and Biochemistry Major

The major in Molecular Biology and Biochemistry (MB&B) emphasizes the application of modern molecular science to study the mechanisms of biological processes. In keeping with the culture of liberal education at Wesleyan university, the MB&B major is designed to accommodate a variety of interests *and* allow students to concentrate in areas such as Molecular Biology, Molecular Biophysics, Biochemistry, Cell Biology, Genetics, Integrative Genomic Sciences, and Computational Sciences and Modeling. The interdisciplinary nature and flexibility of the MB&B major also enables students to couple their affinity for biological sciences with other disciplines including mathematics, computer science, psychology, economics, government, anthropology, science in society, chemistry, biology etc. The MB&B major provides excellent preparation for a range of professional careers in medicine, public health, pharmaceutical/biotechnology industry, public policy, science journalism, and teaching, among others.

Typical reasons for becoming an MB&B major include:

- intellectually stimulating environment for life science education
- excellent research opportunities
- practical training in cutting-edge research techniques and equipment
- opportunities to attend national and international scientific conferences
- opportunities to publish research in leading journals
- small class sizes and close contact with faculty members
- access to graduate-level courses
- rigorous training for medical or graduate school
- abundant opportunities for interdisciplinary learning
- becoming part of the molecular life science revolution

The Molecular Biophysics Minor

Molecular Biophysics is an interdisciplinary area situated at the intersection of molecular biology, chemistry, chemical biology, and molecular physics. It underlies many new and important advances in basic and biomedical research. Molecular biophysics is distinguished by an analytical and quantitative mode of inquiry based on molecular structure and spectroscopy, biophysical chemistry, functional bioenergetics, statistical thermodynamics, and molecular dynamics.

At Wesleyan, graduate and undergraduate students work together in small faculty led groups that pursue challenging research problems in protein structure and folding, molecular models of enzyme mechanisms, DNA structure and dynamics, nucleic acid-protein interactions, molecular recognition, the nature of gene expression and regulation, membrane dynamics and membrane proteins. As a consequence of recent advances stemming from the human genome project, the field of structural bioinformatics finds an increasingly important emphasis in our program. A parent organization for this field of research is the U.S.-based Biophysical Society, with some 7,000 members, and sister societies worldwide.

As Molecular Biophysics is an interdisciplinary minor, it is strongly recommended that undergraduate students gain foundational knowledge by majoring in one of these three areas: Molecular Biology and Biochemistry, Chemistry, or Physics.

INFORMATION FOR MB&B MAJORS

Where to get advice

The advising system for MB&B majors is designed to provide clear and accessible information, tailored to the needs of individual students. Upon declaring the major, each student is asked to choose an MB&B faculty member as a primary advisor (or is assigned an advisor). The faculty advisor's role includes:

1. helping students select and fulfill departmental and university requirements for graduation;
2. providing timely guidance on the student's curriculum and future career plans;
3. responding to student requests for specific assistance with career development, such as writing letters of recommendation, etc.

Importantly, all MB&B faculty observe an open-door policy for students, and are available to help students with any number and variety of issues. Students are encouraged to engage with many, if not all, members of the MB&B faculty and graduate students to increase the breadth and depth of their connections within the department.

Biophysics: Ishita Mukerji (imukerji@wesleyan.edu), Rich Olson (rolson@wesleyan.edu)
Informatics and Modeling: Robert Lane (rlane@wesleyan.edu)
Pre-Major: Michelle Murolo (mmurolo@wesleyan.edu)

General questions about the major, curriculum, and administrative issues can be answered by the MB&B administrative assistant Mary Readinger (mreadinger@wesleyan.edu, x2409) in Hall-Atwater, Room 242.

The Career Resource Center also serves as a useful source of information (x2180; crc@wesleyan.edu)

Entry into the MB&B Major

Most MB&B majors start by taking the Introductory Biology course, MBB/BIOL 181, and the associated laboratory, MBB/BIOL 191, in their first semester.

Students may take MBB/BIOL 181 (any section) in either first semester freshman year or first semester sophomore year; however, starting the sequence in the first year allows more curricular flexibility in later years.

We recommend that students, especially those intending to major in the life sciences, take introductory chemistry concurrently or prior to MBB/BIOL 181.

Students should enroll separately in MBB/BIOL 191.

NOTE: The Introductory Biology series counts towards the NSM General Education expectation.

Advanced Placement

Students with AP Biology scores of 4 or 5 may be eligible to take a test for placing out of MB&B181 after consulting with the MB&B department. However, even students with an AP Biology score of 4 or 5 are strongly encouraged to enroll in MB&B181, since the AP Biology course does not include the full range of topics discussed in MB&B181, and since very few students have been able to pass the place-out test when requested.

Students interested in placing out of MB&B181 in the fall semester should contact Professor Cori Anderson (canderson@wesleyan.edu) regarding the placement exam.

Both MB&B181 and MB&B182 are considered essential preparation for our upper-level courses; students are highly encouraged to enroll in both semesters.

Prospective MB&B majors with a score of 4 or 5 in AP Chemistry must meet the Chemistry Department requirements for advanced placement credit.

AP credit is not accepted for the math requirement.

Additional Recommendations

In addition to attending introductory biology class, students are strongly encouraged to take advantage of opportunities for intellectual enrichment and assistance available beyond the required lectures and labs. For each course, there are office hours and help sessions held both by the instructor and by teaching assistants, regularly scheduled throughout the week and by appointment. There are also mentored study groups, in which students in each course are set up in groups of 3 - 5 to meet regularly with a mentor who has taken the course previously, to go over course material and to share study hints and problem-solving strategies.

This recommendation applies broadly to all MB&B courses and majors.

Additionally, the science community is enriched by the weekly departmental and inter-departmental seminar series, in which highly distinguished scientists are invited to speak about their work. Some of the material may be more suited to upper-level students, but all students are encouraged to attend and engage with the latest research in the life sciences.

Major Requirements

Below are the required courses that comprise the MB&B major. The sequence of courses shown is an ideal one; however, the major can be readily accommodated even if begun after the first year.

Year	Fall Semester	Spring Semester
1st Year	MB&B 181 Principles of Biology I MB&B 191 Principles of Biology I Lab CHEM 141 or 143 Intro Chemistry I	MB&B 182 Principles of Biology II MB&B 192 Principles of Biology II Lab CHEM 142 or 144 Intro Chemistry II
Sophomore	MB&B 208 Molecular Biology CHEM 251 Organic Chemistry I Mathematics (e.g. Calculus or Statistics)	MB&B elective (200 level or above) CHEM 252 Organic Chemistry II MB&B 209 Research Frontiers in Molecular Biology (optional)
Junior	MB&B 395 Structural Biology Lab MB&B 383 Biochemistry	MB&B 394 Advanced Lab in Molecular Biology and Genetics MB&B 381 Physical Chemistry for Life Scientists
Senior	MB&B elective	MB&B elective

We require one semester of a Chemistry lab course, which would typically be satisfied by Introductory CHEM 152 (but could be satisfied instead by the Intermediate Chemistry Lab, CHEM 257). The Chemistry lab may be taken in fall or spring.

One semester of college mathematics is required (AP credit is not accepted). Students with deep theoretical knowledge in areas of mathematics, as evidenced by advanced coursework (e.g., in physics) or quantitative forms of research, may petition for the use of a less theoretical mathematics course (e.g., QAC courses) to satisfy the MB&B math major requirement.

One advanced laboratory class is required. Majors interested in a concentration in molecular biology should take MB&B394, which is offered every spring semester and generally taken in the junior or senior year. Students interested in the molecular biophysics minor should take MB&B395, which is offered every other year in fall semester. The Chemistry Integrated Laboratory courses (CHEM375 and CHEM376) do not satisfy this requirement. Students taking both of the advanced lab courses (MB&B394 and MB&B395) may count one of the two courses as their 300-level elective.

MB&B381 may be replaced by two semesters of Introductory Physics (PHYS111 and PHYS112, or PHYS113 and PHYS116) or by Physical Chemistry (CHEM337 and CHEM338). In this case MB&B381 may count as one of the required 300-level electives.

One of the two required electives must be a 300-level MB&B course. This may be fulfilled by taking a 1.0-credit 300-level course, or by taking two 0.5-credit 300-level courses.

The second elective may be a 200-level or 300-level MB&B course. Two consecutive semesters of research (in the same laboratory) for credit (MB&B423 and MB&B424, Advanced Research Seminar) with an MB&B faculty member (or a pre-approved faculty member in another department conducting research in molecular biology/biochemistry/biophysics) can be substituted for the 200-level elective, provided that it is taken for 1.0 credit each semester and a grade of B or higher is achieved. Honors Thesis (MB&B409 and MB&B410) may not be used to satisfy an elective requirement.

For potential elective courses outside of MB&B, including study abroad courses, students must consult with their faculty advisor and the MB&B chair in a timely manner. Prior approved courses outside MB&B that can be taken to satisfy the lower-level elective requirement include BIOL218 Developmental Biology, BIOL334 Shaping the Organism, and CHEM396 Molecular Modeling and Design. These courses offered by other (non-MB&B) departments may only be used to satisfy the 200-level elective requirement for completion of the MB&B major (even if the course has a 300-level designation).

All courses credited toward the MB&B major, both those hosted inside and outside the department, must be taken for a letter grade.

All of the life science community is enriched by the weekly departmental seminar series held on Wednesdays at 12:10pm during the Academic Year, in which speakers are invited from different institutions to speak about their work. All are welcome to come learn about the latest cutting-edge research in the life sciences. You may receive a quarter credit for your attendance by enrolling in MB&B338 and/or MB&B339.

Research Opportunities

Independent laboratory research is strongly encouraged, as it provides students with an exceptionally valuable learning experience. As research students, MB&B majors interact with faculty and graduate students in an environment that fosters strong intellectual and social connections. Moreover, many graduate and professional schools specifically recruit candidates with research experience. MB&B majors not interested in laboratory research can also get a measure of this experience through participation departmental and inter-departmental seminar series and journal clubs.

Faculty research interests cover an exciting range of current topics in molecular and cellular biology and biochemistry. Students are encouraged to learn more about ongoing research in the MB&B department through this brochure (pages 11 – 28), the department website (http://www.wesleyan.edu/mbb/) and through conversations with faculty and students.

MBB 209 Research Frontiers in Molecular Biology, a 0.5 credit (Cr/U) course taught in spring, offers students the opportunity to discuss research with current MB&B majors and graduate students.

Students interested in research can pursue the following options:

Independent research for course credit

For initial entry into the world of research, most students sign up for a semester of research for 0.5 or 1.0 credit (MB&B423 or MB&B424). This option allows students to test the waters with respect to research topics, environment, faculty, and graduate students in the department, without an overly long or binding commitment. Students are expected to dedicate at least 10 hours per week on their research project, which includes attendance in weekly group meetings and reading and discussion of current literature with group members, in addition to planning and performing experiments. In order to register for this individual tutorial, students must choose a faculty research mentor and submit an electronic tutorial form using the drop/add system in their Portal. This course may be taken more than once.

CIS Summer Research Fellowship

For a more intense research experience, students can apply for a Summer Research Fellowship.

Students should contact potential faculty mentors by early Spring semester of the year they intend to apply for a summer research fellowship. Students submit their applications after discussing and developing a research plan with their mentor (in early March). Application information and forms are available on the CIS webpage: https://www.wesleyan.edu/cis/summer-program/index.html.

Honors thesis research

Students who continue to do research beyond a semester or summer can work towards a Senior Honors thesis. In order to be considered for departmental honors, a student must:

- Be a MB&B major and be recommended to the department by a faculty member. It is expected that the student will have a B average (grade-point average 85) or higher in courses credited to the major.
- Submit either a research thesis (based on laboratory research) or a library thesis (based on library research) carried out under the supervision of a member of the department.

Combined BA/MA program

The five-year combined BA/MA degree program in Molecular Biology and Biochemistry enables exceptional students with a strong interest in this life science research to accelerate their professional education (the fifth year is tuition-free). This option is used by students whose research is well underway and usually at an exciting stage in their Junior or Senior year. Students can apply to the program with the approval of their faculty research mentor. The application is online and has a deadline of January 13. Students completing the BA in six or eight semesters apply to the BA/MA program by January 13 just prior to their final semester. Students completing the BA in seven semesters apply to the BA/MA program by January 13 just prior to their sixth semester. More information is available on the Graduate Studies webpage at https://www.wesleyan.edu/grad/graduate-programs/index.html.

Teaching opportunities

There are several opportunities for advanced MB&B majors to serve as course assistants in introductory and advanced courses. Participating students get pedagogical experience that is particularly valuable for students considering graduate studies and an academic career. The experience can also help strengthen connections between students and faculty members. As teaching/course assistants, MB&B majors are usually tasked with holding review sessions and office hours for students in the class. Students can get course credit or may be paid for their service.

Studying abroad

Like all Wesleyan students, MB&B majors often choose to study abroad for a semester or more. In the past few years, MB&B majors have visited Australia, Chile, Denmark, South Africa, England, France, Tanzania, and Germany, among other countries. During their semester abroad, MB&B majors may choose to take courses that satisfy their major or general education requirements and may also arrange

to do research at the host institution. Decisions about whether courses taken abroad can count for credit towards the MB&B major are made by the department on a case-by-case basis. Students must have the appropriate "course approval" form signed before departure by the Chair of the MB&B department, and should check in with the Chair if they make changes to their schedule on arrival at their host institution.

Students considering a study abroad experience should begin planning for it at an early stage in the major. The planning process should include consultation with their MB&B faculty advisor and research advisor. Detailed information about the Wesleyan Study Abroad Program can be found on the website for the Fries Center for Global Studies at https://www.wesleyan.edu/cgs/osa/.

Recommendations for students considering the health professions

If you are considering applying to medical school, you need to familiarize yourself with the course requirements. Generally, three or more years are needed to complete these required courses as an undergraduate:

- 1 year of biology with laboratory
- 1 year of general chemistry with laboratory*
- 1 year of organic chemistry with laboratory*
- 1 semester of biochemistry (CHEM 383 or MB&B 228)
- 1 year of physics with laboratory
- 1 year of English
- 1 year of college math (we recommend one semester of statistics and one of calculus or linear algebra)

Chemistry Laboratory Requirements; Most medical schools are aware that Wesleyan offers two semesters of general chemistry lab, CHEM 152 (.25 credit) and CHEM 257 (.50 credit), and only one semester of organic chemistry lab, CHEM 258 (.50 credit). Together, these three laboratory courses meet the chemistry lab requirements for medical, dental and veterinary schools, optometry, etc. All courses need to be completed with a grade of C or higher. Students should repeat any pre-requisite course with a grade of C- or lower.

Advanced Placement: At most medical schools, Advanced Placement or departmental exemption will not excuse you from their requirements; you will be expected to take the equivalent in higher-level courses in that particular discipline. AP Calculus is an exception to this rule (see below).

Math Requirements: The math requirement varies widely from school to school; many schools require no math at all, while a few require a full year of calculus, and others require statistics. To keep all options open, we recommend taking a year of college math; one semester of calculus and one of statistics. Some schools have other specific requirements, such as biochemistry. The newly revised MCAT (Medical College Admission Test) now includes questions that require a knowledge of biochemistry and statistics, and while some schools do not specifically require biochemistry, they do highly recommend foundational knowledge in the area of biochemistry.

The university's health professions advisor is available to assist you in planning how to complete the admission requirements. For those of you who are considering medicine well into or beyond your undergraduate years, there are post-baccalaureate pre-medical programs throughout the country. These programs allow you to complete medical school requirements in one or two years of intense study.
These required courses may also be taken while enrolled as a special undergraduate student at any four- year US college or university.

Be aware that there are many myths about medical school requirements and appropriate majors. If you are not sure that what you have read or heard is accurate, check with the Health Professions Advisor. If you hear something unusual about a particular school that you are interested in, look at the school's Web site or contact the medical school admissions office directly by e-mail.

Criteria for Admission: Competition for admission is keen at all US medical schools. Nearly all of the schools quote an average GPA that falls somewhere between A- and B+ — roughly 3.5/4.0 or 90.00 on the Wesleyan scale—as representative of successful applicants. Academic achievement is considered carefully by admissions committees. Unless you have no choice, we recommend that you choose grades over pass/fail in all courses. Pass/fail courses make it more difficult for admissions committees to evaluate your performance. Keep in mind, however, that grades by themselves do not tell the full story. Faculty recommendations are also very important in helping admissions committee members to appreciate and assess your abilities. Admissions committees also pay attention to the difficulty of courses you select, the breadth of your curricular interests, and where you took your courses. Admissions committees look carefully at how engaged a person is with their community, the depth of any research or volunteer experience, and the degree of familiarity with clinical medicine and health care evident through volunteer work and/or employment.

As the national application picture stands at present, one out of two candidates to US medical schools (MD and DO) will not be admitted, even though they may be very qualified applicants. While most Wesleyan graduates do well in the application process, you should apply only when you are personally ready and a strong candidate. An excellent senior year can greatly improve chances for admission and a glowing recommendation from a thesis advisor is very helpful. For individuals with an overall or science/math GPA below a B+ at the end of senior year, we suggest you consider taking additional courses after graduation and/or work in a laboratory or clinical research setting; these experiences will enable you to develop a greater understanding of medicine, acquire valuable new skills, and further strengthen your medical school application.

Visit the Gordon Career Center Health Professions website (https://careercenter.wesleyan.edu/channels/health-professions/) for more information and assistance.

MB&B FACULTY

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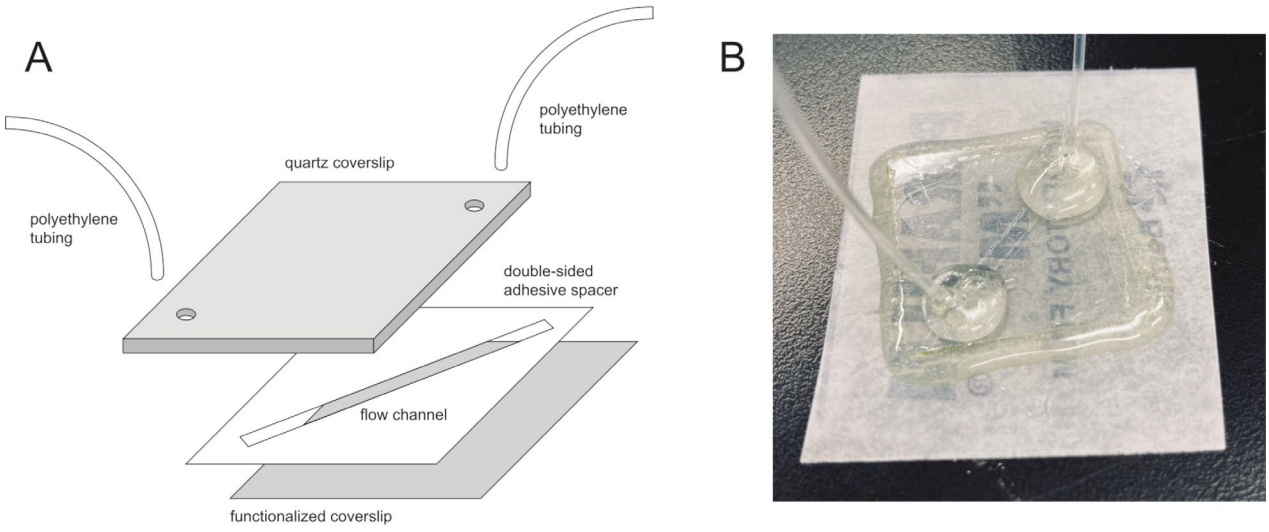
Single-Molecule Biophysics of Protein-DNA Interactions

Proteins and DNA constantly interact with one another and are inextricably linked by the Central Dogma and the critical need for maintenance and faithful transfer of genomic information from mother to daughter cells. It is therefore not surprising that aberrant protein-DNA interactions play a major role in the disease process of cancer, and are implicated in a growing number of other diseases. Most established techniques for studying protein-DNA interactions are heavily biased toward stable, long- lived interactions. Yet many important interactions are transient and dynamic, and therefore difficult to observe and characterize using these methods. Furthermore, the mechanisms of many proteins that modify DNA are poorly understood. Studies of these proteins at the single-molecule level have already provided insights into protein-DNA interactions and they have the potential to offer much more.

Our goal is to develop new tools and approaches for the study of proteins that interact with and/or modify DNA utilizing fluorescence spectroscopy and single-molecule fluorescence microscopy. In the process, we also hope to address some fundamental questions about the nature of bimolecular interactions and catalysis at the single molecule level.



Microfluidic flow cell device. (A) Exploded view showing the three layers used to create the device: the functionalized glass coverslip on the bottom, the quartz slide with inlet and outlet holes on the top, and the double-sided adhesive imaging spacer with a channel cut into it sandwiched in the middle. (B) A completed device with polyethylene tubes sealed in place and with edges coated with epoxy.

We are currently investigating the mechanism by which BcnI, a rare monomeric Type IIP restriction endonuclease, cleaves duplex DNA. BcnI appears to engage in "flipping", which is a rotation of the protein about an axis perpendicular to the DNA strand that cannot be achieved without changing the mode of contact with the DNA backbone. Flipping is a critical step in the mechanism for HIV reverse transcriptase, and it may play a role in the cleavage mechanism for several other monomeric Type IIP restriction endonucleases. We are using a total internal reflection fluorescence (TIRF) microscopy-based assay to directly observe BcnI-mediated DNA cleavage at the single-molecule level. With this assay, we can simultaneously measure the length of the catalytic cycle for hundreds of individual restriction endonuclease molecules in one experiment. We can then analyze the resulting dwell-time distributions, which can provide insights into the DNA cleavage mechanism by revealing the presence of kinetic steps that cannot be directly observed. By observing BcnI-mediated DNA cleavage under a range of conditions that can selectively stabilize (or destabilize) certain types of interactions, we aim to establish a model for BcnI flipping. To better understand protein flipping on DNA in a general sense, we also plan to identify and study other restriction endonucleases that engage in flipping.

We also have an ongoing collaboration with the Mukerji Lab in which we are using single-molecule FRET to observe how protein binding impacts conformational dynamics of Holliday junctions. Holliday junctions are four-way junctions that form between two double-stranded DNA molecules during the processes of double-strand break repair and homologous recombination. These junctions can adopt either an open or stacked conformation, in which the open conformation facilitates the process of branch migration and strand exchange. We can use single-molecule Förster resonance energy transfer (FRET) to directly observe Holliday junctions fluctuate between stacked and open states. *E. coli* nucleoid- associated proteins, such as integration host factor (IHF) and the histone-like protein HU, bind to Holliday junctions and can stabilize either the open or stacked conformation, which results in altered dynamics. Understanding how these proteins bind to Holliday junctions can provide insight into what roles they play in recombination.

Educational research

In addition to single-molecule biophysics research, Prof. Etson also has an active physics education research project, examining how to support student learning in first-year physics courses. She is co-PI on an NSF funded research coordination network that aims to develop evidence-based inclusion strategies to support professional societies in addressing persistent challenges that frequently undermine diversity efforts within their communities of practice.

Funding: National Science Foundation

Current lab members: Eugene Gato Nsengamungo, Audrey Morgan Lavey, David Jusino, Omar Gonzalez

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Chromatin structure and chromosome dynamics in budding yeast

The primary structural component of the eukaryotic chromosome is the nucleosome, a DNA-protein complex composed of four different core histone proteins (two copies each) wrapped by 147 bp of DNA. Each of these histones can be modified to create nucleosomes with unique characteristics, including the ability to promote or discourage gene expression. Therefore, a "histone code" exists that imposes regulation on the genetic code found in our DNA sequences. Our experiments on chromosome structure take advantage of the advanced molecular genetics of budding yeast, a single-celled eukaryote. A powerful combination of classical genetics, molecular biology, and biochemistry can be applied to address the biology of yeast, and these findings are generally applicable to all eukaryotes.

Sir protein dependent gene silencing

Yeast uses a mechanism known as gene silencing to regulate expression of genes that dictate the developmental program of the cell. Silencing is achieved by formation of the yeast equivalent of heterochromatin, a repressive chromatin structure. Once established, this gene repression is epigenetically inherited; the expression state becomes a permanent, heritable property of the gene. We have had a long running interest in determining the mechanism of epigenetic inheritance. As part of this effort we have focused on the function of the Sir2 silencing factor. Yeast Sir2 is the founding member of a large family of "sirtuin" proteins found in virtually all species, including humans. Eukaryotic sirtuins often function as protein deacetylases and have been shown to regulate lifespan in many species. We discovered that GAPDH, a glycolysis enzyme, interacts with yeast Sir2 and affects transcriptional silencing, providing a link between basic metabolism and gene repression. We are determining the mechanism of this regulation and exploring the general effects of metabolism on the efficiency of silencing in yeast.

Histone variant H2A.Z and linker histone H1

In addition to the four core histones, a fifth "linker" histone, H1, exists in almost all eukaryotes. The specific contributions of histone H1 to chromosome structure and function are much less well characterized than the core histones. Stemming from an initial observation that H1 appears to be an antagonist of gene silencing in yeast, we have initiated several projects to define H1's roles. To examine how H1 interacts with the nucleosome we have eliminated the gene for histone H1 in a set of four hundred yeast strains, each with a unique mutation in either the histone H3 or H4 genes. This effort yielded evidence for a variety of H1 functions that we continue to characterize. We have also uncovered an interesting interaction between

histone H1 and the variant histone H2A.Z. H2A.Z is present in approximately 10% of nucleosomes in yeast and has specific roles in promoting inducible gene expression. Recent experiments conducted in our lab suggest that H1 plays a role in targeting H2A.Z to the chromosome.

Current lab members: Lorencia Chigweshe, Rebecca Schvartsman, Gabrielle Chernomorsky, Sabrina Ladiwala, Gwyneth MacDonough, Simon Moss

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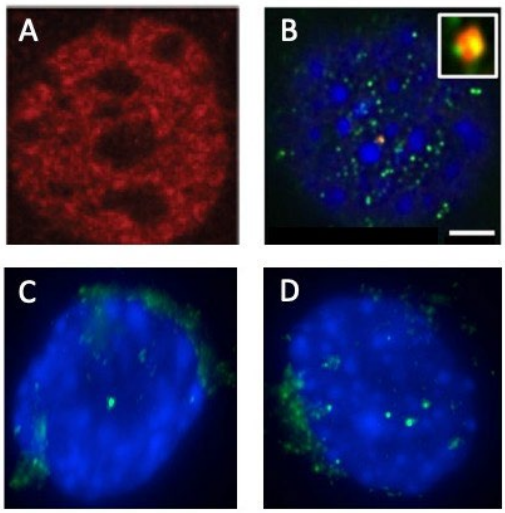
Gene co-regulation in the developing olfactory system

The olfactory system is a primal sensory system for most animals. The sense of smell is required in order for animals to detect food sources, avoid predators, and find mates. Our laboratory is interested in the development of the mammalian olfactory system in consideration of two specific questions: (1) How do olfactory neurons develop the capability to detect and distinguish among the thousands of olfactory cues in the environment? (2) How are olfactory neurons and supporting olfactory tissues maintained given constant insult from toxins, viruses, and bacteria inhaled into the nose?

Odorant receptor transcriptional gene regulation underlies the ability to distinguish odorants Encoded in the animal's genome are about 1,000 odorant receptor (OR) proteins that are expressed in the olfactory sensory neurons of the nose. Each OR protein interacts with a particular chemical structure present in an odor, and upon binding that structure, the neuron fires an action potential to communicate the presence of that chemical structure to olfactory processing centers of the brain. A critical organizing principle during development of olfactory sensory neurons is that each neuron expresses one, and only one, OR protein. Thus, each sensory neuron is tuned to detect a specific chemical structure; each "smell" is recognized as a composition of several specific chemical structures. A major component of our research is focused on the gene regulatory problem that underlies sensory neuronal specialization: how does each neuron express only one OR gene and silence all the other ~999 OR genes?



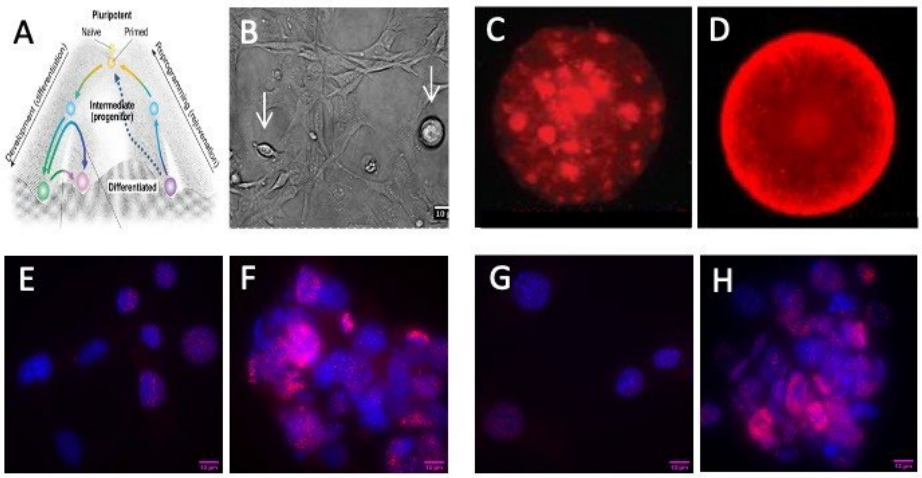
LSD1 protein as the "gatekeeper" for OR transcription.

A. LSD1 protein (red) is broadly distributed in the nucleus of an early developing olfactory sensory neuron (a single nucleus is shown). B. LSD1 protein (red) becomes consolidated into a single spot in the nucleus at later stages, and this LSD1 compartment associates with only one OR gene (all OR gene loci are shown in green). The inset panel zooms in on the single red LSD1 compartment with only one OR gene locus in association (yellow spot).

C. Only one OR gene is transcribed per cell (single green spot detecting OR RNA at the one transcribed locus in the center of this cell). D. When LSD1 protein is knocked down using RNAi techniques, multiple OR loci are transcribed (multiple green spots detecting OR RNA at numerous transcribed loci at once in this cell

An epigenetic model for OR co-regulation

Work in our lab and elsewhere has clarified that the selection of one and only one OR gene in each developing neuron is established by licensing only one OR locus with permissive chromatin, while maintaining repressive chromatin states at other non-selected loci. How does one OR locus become licensed in this way? Recent work has focused on a key chromatin regulatory protein, the lysine-specific demethylase-1 (LSD1), whose biochemical function is to remove methyl groups from histone-3 side chains within chromatin. Interestingly, LSD1 is able to function as either a repressor, through removing the activating histone methylation mark on the H3K4 residue, or an activator, through removing the repressive histone methylation mark on the H3K9 residue. As shown in the figure (Panels A&B), we have identified a shift in LSD1 protein distribution, where we hypothesize that the former stage is associated with globally repressing OR expression (via H3K4 demethylation) and the latter stage associated with selectively activating only one OR gene (via exclusive H3K9 demethylation) To further investigate, we are currently using transgenic/CRISPR-Cas9 techniques to perturb LSD1 function (see Panels C&D) in order to test the hypothesis that LSD1 functions as the key master regulator in OR selection (e.g., does LSD1 genetic perturbation result in premature OR activation at earlier stages and/or failure to select at later stages?). We are also using proteomic approaches to understand how (e.g., through LSD1 post-translational protein modifications and/or modulating binding partners?) and why (e.g., caused by some developmental or cell cycle cue that instructs the neuron to take this developmental step?) the LSD1 protein switches its functionality during this critical moment of choice during neuronal maturation.



G9a protein as a "gatekeeper" for cell-type stability? A. Cell differentiation depicted in a landscape metaphor, where normal differentiation of cell types flows irreversibly downhill along one valley. Does G9a perturbation cause up-hill "de-differentiation" into a more pluripotent stem cell type? B. G9a perturbation results in changes in cell morphology into a more spherical cell type (arrows) from a typical pre-neuronal cell shape (flattened background cells not marked by arrows). C. and D. Differentiated olfactory neurons have nuclei with heterochromatin distributed in various chromocenters (red blobs, panel C), whereas cells transformed by G9a perturbation have heterochromatin distributed at the nuclear periphery (panel D). E. and F. A core marker of stem cells, Sox2, is up-regulated in transformed cells (panel F) as compared to untreated neurons (panel E). G. and H. Another core marker of stem cells, Oct4, is up-regulated in transformed cells (panel H) as compared to untreated neurons (panel G).

Regenerative capability of the olfactory system

The nose is a messy environment, full of toxins, viruses, and bacteria. As observed with the recent Covid pandemic, temporary loss of the sense of smell is a common symptom of infection, as the virus destroys olfactory cell types as it enters the body through the inhalation of viral particles. Why is this loss of smell only temporary? The olfactory system is one of the few neurological systems capable of regeneration, accomplished primarily through a population of stem cells that reside at the base of the olfactory epithelium. Moreover, it appears that olfactory cell types are atypically "plastic" in their ability to trans-differentiate from one cell type to another (typically, differentiated cell types are robust and stable), presumably in order to meet pressing needs to replenish a certain cell type. Our lab is interested in this developmental "plasticity". We have focused on a second chromatin regulating protein call G9a, which adds repressive H3K9 methylation marks to histone proteins. We have discovered that CRISPR- Cas9 depletion of the G9a protein can cause transformation of an olfactory neuronal cell type to a cell that has stem-cell like properties, including stem-cell like growth properties, changes in shape and nucleus size, gross modification of chromatin organization within the nucleus, and up-regulation of core stem-cell gene networks (e.g., Sox, Nanog, etc.). We are currently using RNA-seq to investigate the activation/deactivation of key genetic networks during this transformation process. In addition, we are testing the hypothesis that these transformed olfactory cell types have de-differentiated and have adopted stem cell characteristics (i.e., multipotency) by attempting to re-differentiate these transformed cells using common stem cell biological cell culturing techniques.

Overview of research goals for students

Our lab uses a wide range of molecular biological techniques ranging from genetics/transgenics, cell biology (cell culturing and microscopy), genomics and bioinformatics, proteomics (protein studies), and chromatin analysis in order to study the development of olfactory sensory neurons. The specific models we are testing should contribute to our understanding of epigenomics – the relationship between chromatin state, gene expression, and cell differentiation – an emerging field important for development of clinical strategies in gene therapy and stem cell research, as well as for our understanding of numerous chromatin-influenced diseases (e.g., cancer).

Current lab members: Ghazia Abbas

Recent lab members: Rutesh Vyas (Ph.D.), Joyce Noble (Ph.D.), Spencer Tang (BA/MA), James Farber (BA/MA), Kate Louderback, Erica Horowitz, Tyler Burdick, Eleanor Walsh, Jenny Margolis, Sabrina Ladiwala, Aiden Parente, Greta Yang

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Meiotic prophase chromosome dynamics

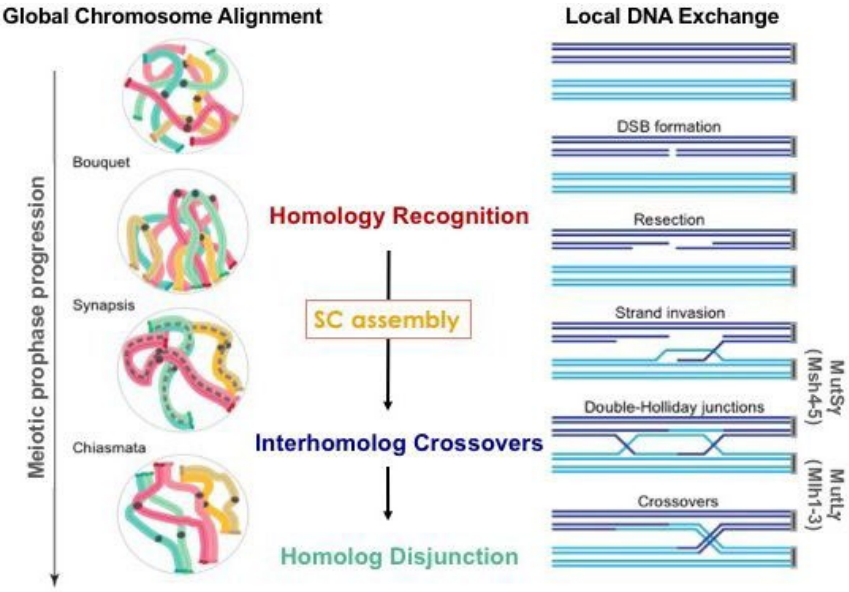
Our research seeks to understand the fundamental, yet long mysterious, cellular mechanisms that drive chromosome dynamics during the differentiation of sex cells (gametes).

A critical feature of gamete differentiation is chromosome reduction; each gamete must contain exactly half the chromosome complement of its progenitor (parent) cell. If chromosomes fail to segregate properly during gamete formation, gametes and the offspring they generate are aneuploid (contain an improper number of chromosomes).

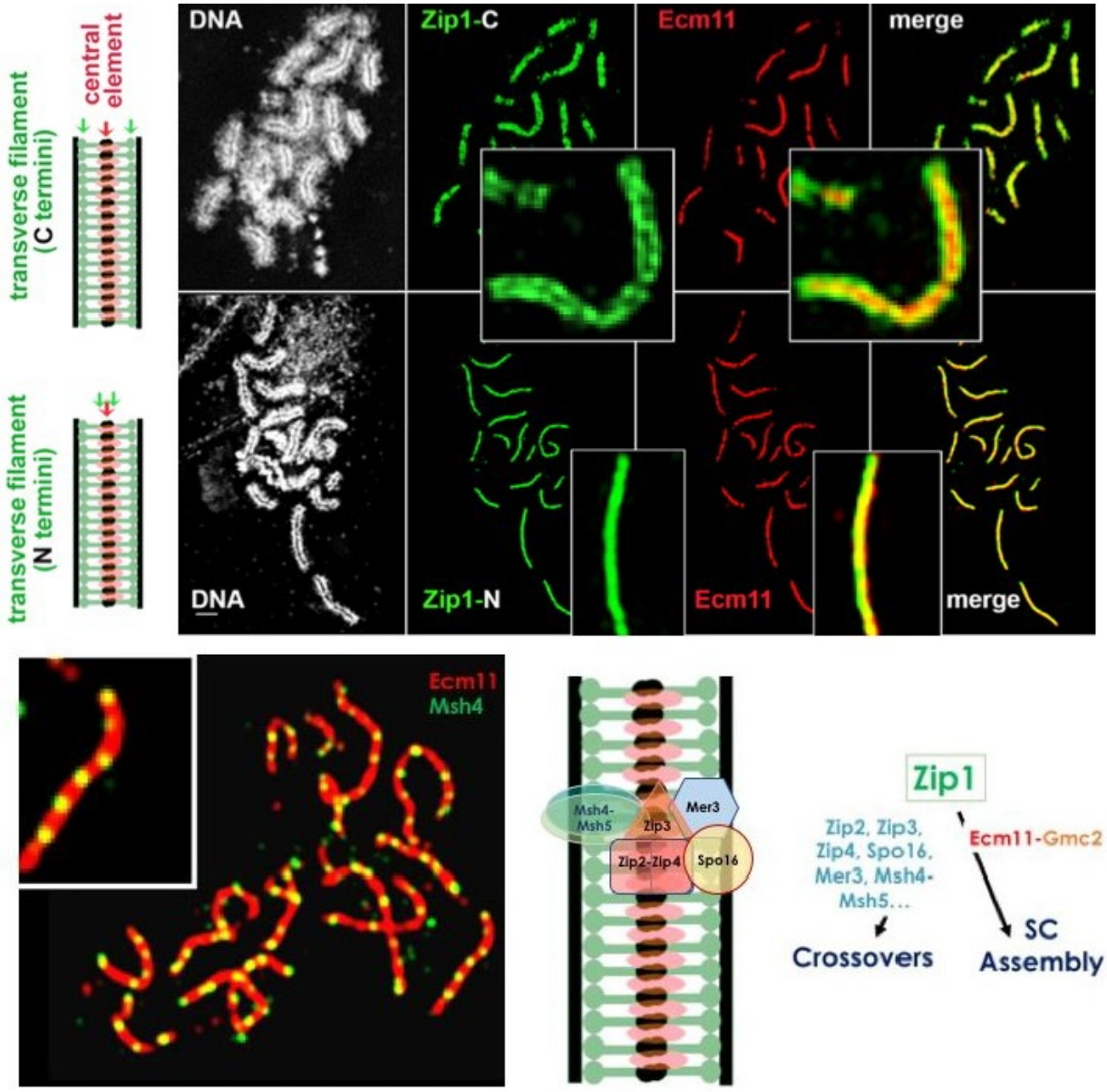
How are chromosome complements properly divided? At the onset of the specialized cell division cycle called meiosis, each chromosome somehow identifies and specifically associates with its homologous partner. This nuclear reorganization process culminates in paired homologous chromosomes that are joined along their lengths by a proteinaceous structure, the synaptonemal complex (SC), and each capable of undergoing crossover

recombination. Each of these steps, chromosome pairing, SC assembly (synapsis) and crossover recombination, are

conserved features of meiosis that ensure accurate chromosome reduction: Together, these steps allow homologous chromosomes to orient with respect to one another and thereby segregate toward opposite spindle poles at the first meiotic division. Despite over a century of observing meiotic chromosome pairing and synapsis in diverse organisms, the molecular mechanisms that promote and coordinate these fundamental meiotic chromosomal events are still unknown. How do homologous chromosomes identify one another? How is this initial recognition between chromosomes reinforced? How is homolog recognition coordinated with SC assembly, such that synapsis occurs specifically between paired chromosomes?

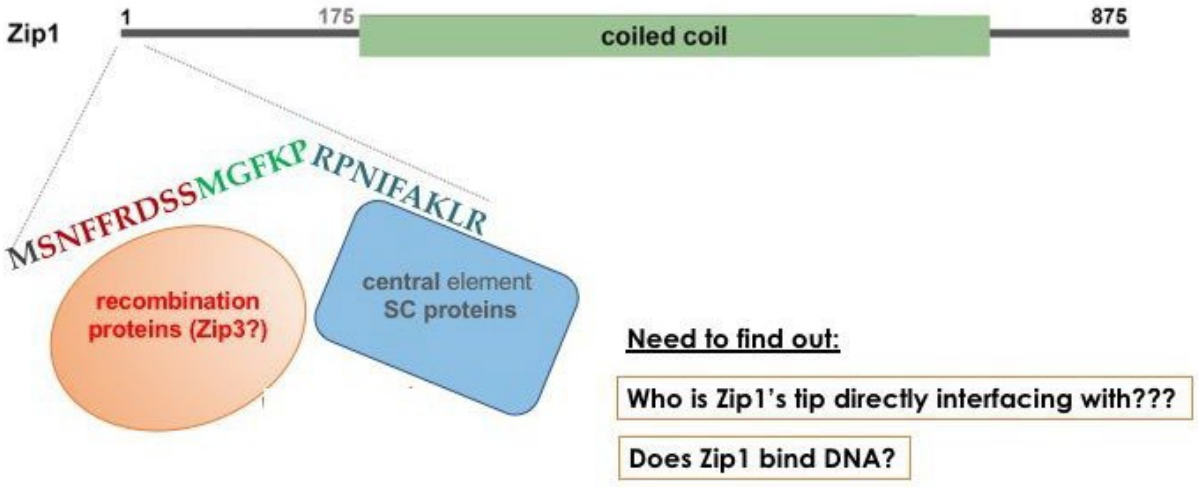


Our research is currently aimed at obtaining a molecular view of SC architecture and of the functional relationship between the structural building blocks of SC (particularly the SC transverse filament protein Zip1) and meiotic crossover recombination in budding yeast. Zip1 is predicted to assemble dimeric rod-shaped units that we know assemble with their C termini oriented toward homolog axes and their N termini oriented toward the midline of the SC. Our lab discovered that the Ecm11 and Gmc2 proteins assemble the central element of the budding yeast SC. This work also brought us to the discovery that, although crossover recombination events take place in the context of the SC, mature SC structure is dispensable for crossover recombination in budding yeast: *ecm11* and *gmc2* null mutants fail to assemble mature SC but exhibit robust (even excess) crossover recombination.



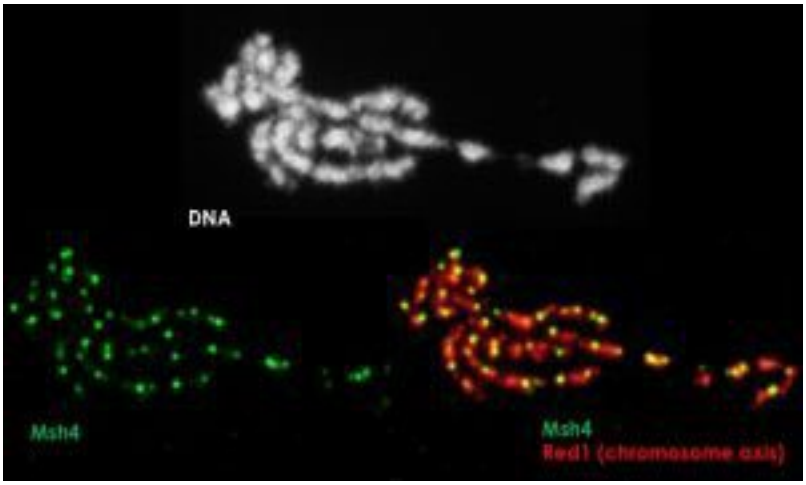
A focus that underlies many of our recent experiments has been to identify molecular partners and features of the SC transverse filament protein Zip1 that underlie its crossover-promoting and SC assembly activities. Our work in this area has demonstrated unequivocally that Zip1's SC assembly and crossover recombination functions are independent.

Furthermore, our data suggests the Zip1 coordinates its crossover-promoting and SC assembly activities through adjacent small regions within its N terminal tip.



We have furthermore established fruitful collaborations with Dr. Owen Davies at Newcastle University, and with Dr. Ishita Mukerji in our own department, to begin analyzing the structural properties of SC proteins, including Zip1 and the Ecm11-Gmc2 heterocomplex.

Our careful phenotypic analysis of crossover recombination in a wide variety of meiotic mutants (primarily the hard work of a large number of undergraduate students over the past two to three years!) also revealed an unexpected link between structural proteins of the SC and mismatch repair, a process that is fundamental to most if not all interhomolog recombination events that occur during meiosis. In collaboration with Dr. Jennifer Fung (UCSF), we have generated genome- wide profiles of mismatch repair in the



meiocytes of our mismatch repair-defective mutants. This dataset confirms our initial genetic evidence of mismatch repair errors in our mutants, and allows us to examine the profile of recombination events that suffer from defective mismatch repair.

A fundamental goal of the lab's current and future research is to understand how homologous chromosome pairing and SC assembly are coordinated with the meiotic recombination process in budding yeast.

Funding: National Institutes of Health

Current lab members: Karen Voelkel-Meiman, Chandni Ravindan, Sabrina Sharmin, Charlotte George, Arpie Bakshian, Gavin Shamis

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DNA recombination and Repair; Protein-DNA Interactions; Nucleic Acid Structure and Dynamics

We employ fluorescence spectroscopic and other biophysical methods to study protein-DNA interactions fundamental to such processes as DNA recombination and repair. One focus of our research program is dynamic mechanisms of recognition in protein-DNA interactions. A particular area of interest is the coding of protein recognition in DNA structure rather than DNA sequence. Our work has also led us to develop FRET mapping methodologies and the use of fluorescent nucleoside analogs such as 6-MI and 6-MAP. In collaboration, we have also used computational methods to complement our spectroscopic studies.

DNA Four-Way Junctions in DNA Repair and Recombination

Many of our studies are focused on DNA four-way or Holliday junctions, a critical intermediate in recombination and repair processes. Our current efforts are focused on the structure and dynamics of this structure with and without proteins bound.

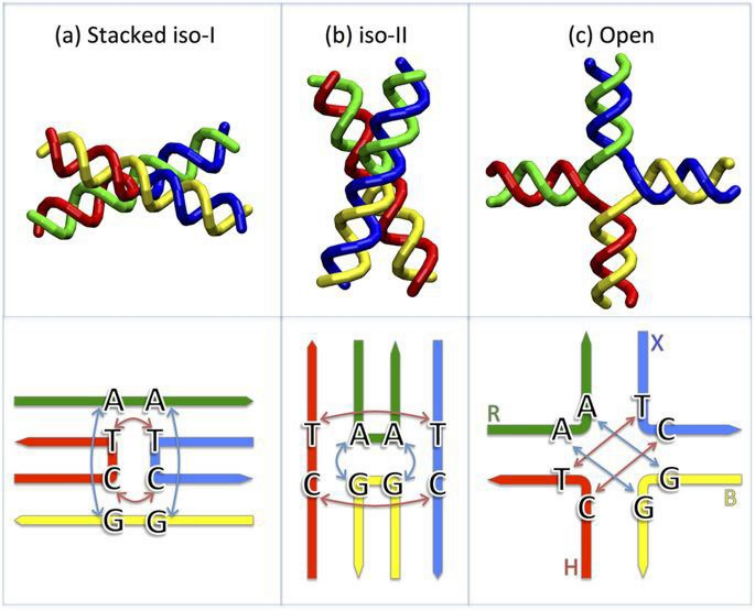
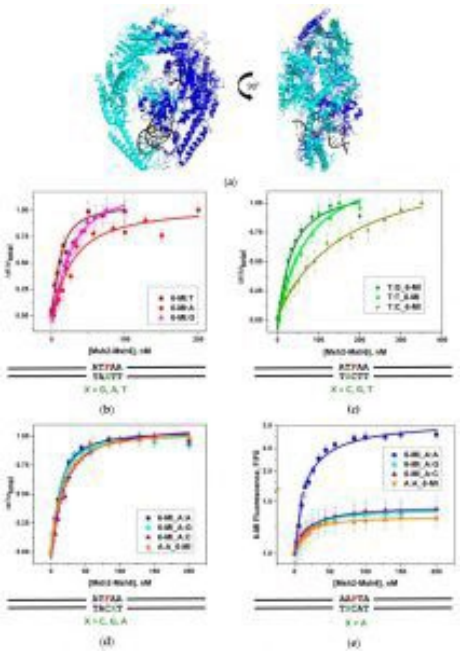


Figure 1: Idealized schematic of the junction conformations. From: Holliday Junction Thermodynamics and Structure: Coarse-Grained Simulations and Experiments

Previously, we have studied the effects of ions and proteins on junction structure. More recently, we have been investigating how the Mut S Homologue (Msh) proteins, Msh2-Msh6 and Msh4-Msh5, interact with the junction structure. Both proteins exhibit high affinity binding to the junction structures. We are currently investigating how the proteins utilize ATP when bound to such structures and protein conformational changes associated with ATP hydrolysis.

Our current work uses these fluorescent probes to examine site-specific base dynamics in the context of protein-DNA interactions. We have successfully applied this methodology to the study of Msh2-Msh6 binding to mismatch DNA and showed that well-recognized mismatches that are efficiently repaired exhibit much higher dynamics in the DNA duplex relative to poorly recognized mismatches and matched DNA.



We have also used this methodology to investigate the amino acid residues involved in the Msh4-Msh5 binding interaction.

Protein-Nucleic Acid Interactions: Architectural Proteins

Nucleotide-binding proteins often play an extremely important role as regulators of genomic function. We are studying the architectural proteins, HU and IHF from E.coli, which bind to the minor groove of DNA through two flexible β-strand regions. These proteins bind to and bend the DNA sculpting it into unique structures requisite for function. We are currently studying the structure and dynamics of the complexes formed between HU and IHF and DNA junctions using x-ray crystallography and single molecule fluorescence methods.

Funding: National Institute of Health

Current lab members: Zane Lombardo, Annie Khan, Tai Lon Tan, Tenzin Yengkey

Donald B. Oliver

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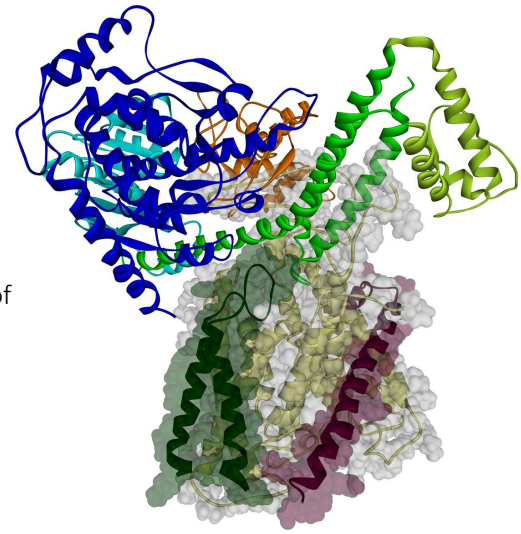
Analysis of protein translocation pathways in bacteria: its genetics, regulation and biochemistry

We are using the simple, well-characterized, and genetically facile bacterium E. coli as a model system to study the molecular details of protein translocation across the plasma membrane. Our major focus is on SecA ATPase, a DEAD motor protein that binds preproteins and the SecYEG channel complex, and which undergoes ATP-driven conformational cycles at the membrane that drive the stepwise translocation of proteins across the membrane. Genetic, biochemical and biophysical approaches are being utilized along with recent X-ray structures of SecA and SecYEG proteins in order to elucidate a number of important questions in this system:

1. SecA ATPase enzymology. SecA is a multi-domain protein whose conformational cycling is regulated by binding nucleotide, preproteins, SecYEG, and acidic phospholipids. SecA mutant proteins are being generated and utilized to define the enzymology of this complex ATPase.
2. SecA association with preproteins and SecYEG. Multidisciplinary approaches are being utilized to define the structural details of SecA interaction with signal peptides, secretory preproteins, and SecYEG and to elucidate their functional consequences in order to work out the protein translocation cycle.
3. SecA dimer function. The nature of the requirement for SecA homo-dimerization in protein translocation is being elucidated.
4. SecA regulation. SecA represses its own translation in response to the protein secretion- proficient state of the cell. This novel form of translational regulation, that utilizes the upstream gene, secM, encoding a secreted protein whose translation and transport are coupled, is being elucidated.



An X-ray structure of SecA (top) bound to the SecYEG channel complex (bottom). The two-helix finger portion of SecA (green alpha helical hairpin) that inserts into the mouth of the channel has been proposed to act as a translocation ratchet to drive protein transport through the channel utilizing the ATPase cycle of the SecA DEAD motor (shown in dark and light blue ribbon).

Rich Olson

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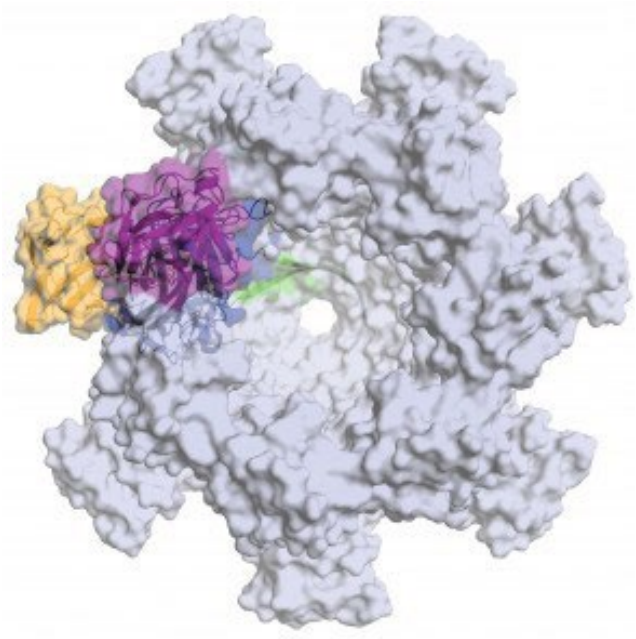
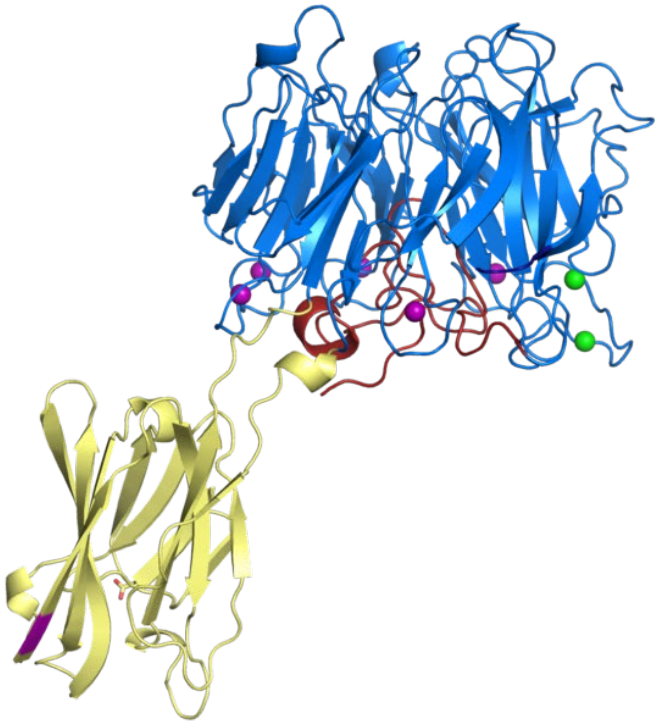
X-ray Crystallography and Biophysical Characterization of Proteins Involved in Infectious Disease

Our research investigates the three-dimensional structure and molecular mechanism of membrane Our research investigates the three-dimensional structure and molecular mechanism of proteins central to infectious disease using crystallographic and biophysical methods. We currently are investigating proteins that mediate host-pathogen interactions involving the human immune system by employing X- ray crystallography to determine high-resolution structures of virulence factors from pathogenic bacteria. We are studying effectors that transform benign environmental bacteria into dangerous human pathogens. Our recent efforts have focused on in two primary areas: pore-forming toxins and biofilm- related proteins. This information will not only provide insight into the pathology of opportunistic human pathogens, but also aid in the engineering of agents for a host of therapeutic and biotechnological applications. These studies seek to delineate the structural underpinnings that allow pathogens to infect human hosts.



Vibrio cholerae cytolysin (PDB:3O44)



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Bap1 Biofilm Matrix Protein from Vibrio cholerae (PDB:6MLT)

Current lab members: Ranjuna Weersekera, Alex Hinbest, Owen Cannizzo, Christine Butawo, Mingyu Wang

Teresita Padilla-Benavides

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Transition metals and cell differentiation

My lab is investigating the biological roles of transition metals, such as Cu, Zn, Co, and Mn, in the development of mammalian cells. Metals play many critical roles in biology as cofactors for a variety of enzymes that are necessary for energy production, tissue maturation, signal transduction and oxidative stress resistance. Metal homeostasis requires chelation by high-affinity binding molecules, transport and sensing by transcriptional regulators to maintain low levels of free metals, as free metals participate in different toxic reactions. How organisms acquire these micronutrients and distribute them to specific cellular compartments or target proteins are subjects of intense scientific interest. Moreover, little is known about how metals and the proteins that handle and distribute them participate in processes that regulate normal growth and development. Eukaryotic genomes encode a wide variety of metal transporters and metalloproteins. Although their biochemical and metal binding properties are relatively well understood, little is known about the fine-tuned regulation of their expression, specificity for metal transport, and the redundancy of functions in the context of cell differentiation and development.

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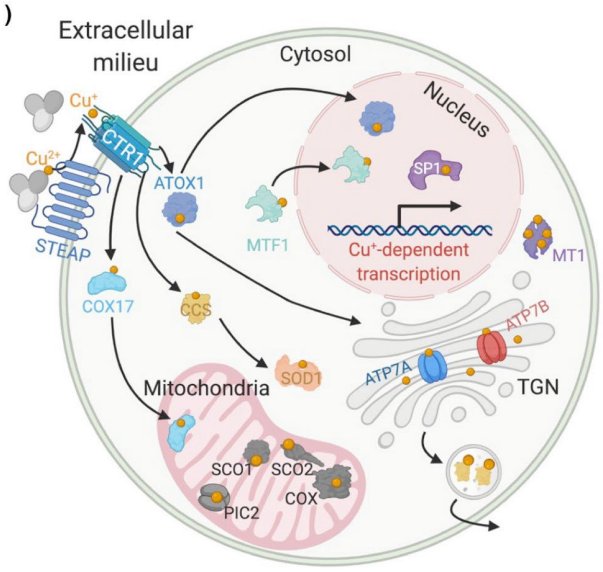
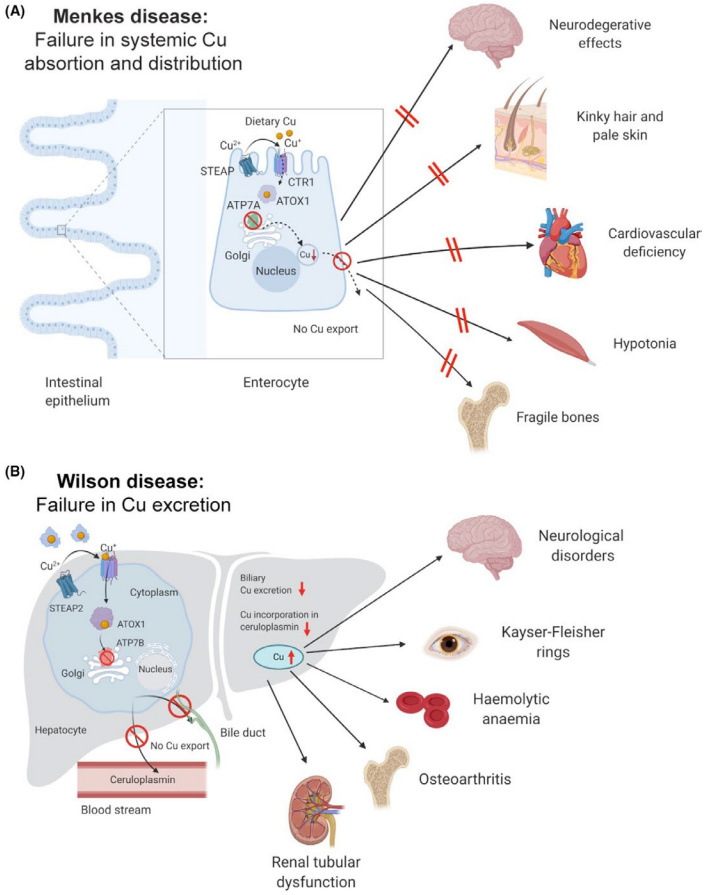


Copper: one ion, different cellular destinations

My lab conducts systematic studies that combine a variety of molecular and cell biology techniques into biological models, including established cell lines and primary cultures. We incorporate diverse biochemistry techniques and combine with high resolution cutting edge synchrotron-based X-ray fluorescence spectroscopy. In particular, we study skeletal muscle differentiation as muscle present an elevated intrinsic need for transition metals like Cu for proper function. This ion is required for mitochondrial energy production as a fundamental component of cytochrome c oxidase which is elevated during the course of differentiation. We hypothesize that the proper cellular distribution of Cu+ has a leading role in the differentiation of the muscle lineage. We have evidence that support different cellular roles for Cu in addition to energy production. Moreover, we hypothesize that diverse devastating myopathies are associated with Cu deficiencies at different levels, from mitochondrial Cu-transport and function to general cellular failure in Cu homeostasis and gene regulation. We hope to provide novel molecular mechanisms that help to understand the basis of muscular phenotypes observed in mitochondrial myopathies and also in Menkes' and Wilson's disease patients.



Current funding: National Institute of Health

Current lab members: Dr. Odette Verdejo-Torres, Jaime Carrazco-Carrillo, Ahmed Almohamed, Denzel Bonilla-Pinto, Imaru DiBartolomeo, Fa'alataitaua Fitisemanu, Emma Johnston, Michael Quinteros, Anand Parikh, Antonio Rivera

Cori Anderson

Associate Professor of the Practice
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My PhD research investigated regulation of mitosis and nuclear dynamics in the multinucleate fungus, *Ashbya gossypii*. Utilizing fluorescence microscopy and various statistical methods, we discovered that nuclei within this common cytosol not only have variable nuclear division timing but that division times are most similar among nuclei within the same lineage, indicating a nuclear intrinsic control of division timing. Further, we discovered that nuclei within this common cytosol have variable numbers of chromosomes suggesting ploidy, like nuclear division timing, is highly variable. I have a particular interest in new advances in microscopy as well as cell cycle and cancer research. At Wesleyan, I concentrate exclusively on classroom instruction teaching Introductory Biology (MB&B181), The Molecular Basis of Cancer (MB&B223), and Introductory Medical Biochemistry (MB&B228).

Michelle A Murolo

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My research training is in the area of molecular microbiology, and I particularly enjoy learning about advances related to the molecular genetics of bacteria. My position at Wesleyan is teaching oriented. I keep very busy teaching and coordinating all of the Principles of Biology labs during both the Fall and Spring semesters. I also teach sections of the Fall Principles of Biology lecture.

MB&B Students

Student Awards 2023

University Awards

Graham Prize

The prize is the gift of James Chandler Graham, Class of 1890, awarded to a member, or members of the graduating class for excellence in natural science.

Edrea Jiang
Aidan Jones

Butterfield Prize

Established by the Class of 1967 and awarded to the graduating senior who has exemplified those qualities of character, leadership, intellectual commitment and concern for the Wesleyan community shown by Victor Lloyd Butterfield, 11th president of the University.

Edrea Jiang

Wesleyan Memorial Prize

The gift of undergraduates in the Class of 1943 in memory of fellow students who made the supreme sacrifice in the Second World War, to the members of the junior class outstanding in qualities of character, leadership, and scholarship.

Mikoto Nakamura

Department Awards

Hawk Prize

The gift of Philip B. Hawk, Class of 1898, as a memorial to his wife, Gladys, to the students who have done the most effective work in biochemistry.

Revi Brown
Edrea Jiang
Aidan Jones
Ellie Kaplan
Rachel Nguyen
Michael O'Sullivan

Scott Biomedical Prize

Awarded to a member or members of the molecular biology and biochemistry senior class who have demonstrated excellence and interest in commencing a career in academic or applied medicine.

Lily Barnes
Bianca Ettinger
Justin Nguyen
Jocelyn Velasquez Baez
Rachel Nguyen

Dr. Neil Clendeninn Prize

Established in 1991 by George Thornton, Class of 1991, and David Derryck, Class of 1993, for the African American student who has achieved academic excellence in biology and/or molecular biology and biochemistry. This student must have completed his or her sophomore year and in that time have exemplified those qualities of character, leadership, and concern for the Wesleyan community as shown by Dr. Neil Clendeninn, Class of 1971.

Bianca Ettinger

William Firshein Prize

In honor of founding faculty member William Firshein, awarded to the graduating MB&B student who has contributed the most to the interests and character of the molecular biology and biochemistry department.

Justin Nguyen

Extramural Awards

Phi Beta Kappa

Edrea Jiang
Aidan Jones
Ellie Kaplan

ASBMB Honors Society

Aidan Jones

ASBMB Sewer Scholarship

Antonio Rivera

ASBMB Undergraduate Research Award

Tai Lon Tan

Watson Fellowship

Jocelyn Velasquez Baez

ASBMB Travel Award

Fa'alataitaua Fitisemanu
Michael Quinteros

SACNAS Travel Award

Lily Barnes

Melnick Travel Grant

Justin Nguyen
Michael Quinteros

Recent publications featuring MB&B Majors

- Cu+ transporter PiC2 (SLC25A3) is a target of MTF1 and contributes to the development of skeletal muscle in vitro. 2022. **Cat McCann**, **Michael Quinteros**, Ifeoluwa Adelugba, Marcos N. Morgada, Aida R. Castelblanco, Emily J. Davis, Antonio Lanzirotti, Sarah J. Hainer, Alejandro J. Vila, Juan G. Navea, Teresita Padilla-Benavides. Preprint at BioRXiv: https://doi.org/10.1101/2022.09.05.506690
- Oxidative reactions catalyzed by hydrogen peroxide produced by Streptococcus pneumoniae and other streptococci cause the release and degradation of heme from hemoglobin. 2022. Babek Alibayov, Anna Scasny, Faidad Khan, Aidan Creel, Perriann Smith, Ana G. Jop Vidal, **Fa'alataitaua M. Fitisemanu**, Teresita Padilla-Benavides, Jeffrey Weiser, and Jorge E. Vidal. Preprint at BioRXiv: https://doi.org/10.1101/2022.08.23.504964
- Surface tension of model tissues during malignant transformation and epithelial–mesenchymal transition. 2022. Irène Nagle, Alain Richert, **Michael Quinteros**, Sébastien Janel, Henry Debost, Véronique Thevenet, Claire Wilhelm, Céline Prunier, Frank Lafont, Teresita Padilla-Benavides, Mathieu Boissan, Myriam Reffay. 2022. Frontiers in Cell and Developmental Biology. Cell Adhesion and Migration section. Special topic on Mechanical and Structural Phenotypes of Cells and Extracellular Matrices Govern Cell Adhesion and Migration. https://doi.org/10.3389/fcell.2022.926322
- ZIP11 Regulates Nuclear Zinc Homeostasis in HeLa Cells and Is Required for Proliferation and Establishment of the Carcinogenic Phenotype. 2022. **Monserrat Olea-Flores, Julia Kan, Alyssa Carlson**, Sabriya A Syed, **Cat McCann**, Varsha Mondal, Cecily Szady, Heather M Ricker, Amy McQueen, Juan G Navea, Leslie A Caromile, Teresita Padilla-Benavides. Frontiers in Cell and Developmental Biology. Cellular Biochemistry section. Special topic on Bioinorganic Chemistry of Metals in Cell Function and Disease. https://doi.org/10.3389/fcell.2022.895433
- Differential requirements for different subfamilies of the mammalian SWI/SNF chromatin remodeling enzymes in myoblast cell cycle progression and expression of the Pax7 regulator. 2022. Teresita Padilla-Benavides**, Monserrat Olea-Flores, Yaje Nshanji**, May T. Maung, Sabriya A. Syed, and Anthony N. Imbalzano. BBA – Gene Regulatory Mechanisms. 1865(2): 194801. doi: 10.1016/j.bbagrm.2022.194801.
- **Tang, S**, Abbas, G., Noble, J.C., and Lane, R.P. (2021). Olfactory receptor coding sequences function as silencing elements in an olfactory placode cell line.
- Voelkel-Meiman, K., **Cheng, S. Y., Parziale, M., Morehouse, S., Feil, A**., Davies, O.R., de Muyt, A., Borde, V., MacQueen, A.J. Crossover recombination and synapsis are linked by adjacent regions within the N terminus of the Zip1 synaptonemal complex protein. PLoS Genetics 2019 15(6):e1008201.
- (2020) **M Joshi**, Y Li, Z Lombardo, M Hingorani, I Mukerji, The FASEB Journal 34 (S1), 1-1
- Elucidation of Interactions between Integration Host Factor and a DNA Four-Way Junction (2021**) SH Lin, D Zhao**, I Mukerji, CM Etson, Biophysical Journal 120 (3), 34a
- Elucidation of Interactions between Integration Host Factor and a DNA Four-Way Junction (2021) **SH Lin, D Zhao**, I Mukerji, CM Etson, American Society for Molecular Biology and Biochemistry, poster presentation
- Banerjee, T., Zheng, Z., **Abolafia**, **J**, Harper, S., Oliver, D. 2017. The SecA protein deeply penetrates into the SecYEG channel during insertion, contacting most channel transmembrane helices and periplasmic regions. J. Biol. Chem. 292: 19693-19707.
- Kaus, K., **Biester, A., Chupp, E., Lu, J., Visudharomn, C.**, Olson, R., (2019) "The 1.9 Å crystal structure of the extracellular matrix protein Bap1 from Vibrio cholerae provides insights into bacterial biofilm adhesion," Journal of Biological Chemistry, 294(40), 14,499-511.
- De., S., Kaus, K., **Sinclair, S.,** Case, B. C., Olson, R., (2018) "Structural basis of mammalian glycan targeting by Vibrio cholerae cytolysin and biofilm proteins." PLOS Pathogens, 14(2):e1006841.
- Ringel, A.E., R. Ryznar, H. Picariello, **K-L. Huang**, A. G. Lazarus, and S. G. Holmes, 2013. Yeast Tdh3 (glyceraldehyde 3-phosphate dehydrogenase) is a Sir2-interacting factor that regulates transcriptional silencing and rDNA recombination. PLOS Genetics 9 (10): e1003871.

Career paths of MB&B majors

Recent majors have gone on to pursue:

- PhD degrees at universities including Johns Hopkins University, Caltech, Stanford University, Harvard Medical School, University of Wisconsin, Medical School, University of Virginia, as well as MS degrees at Yale School of Public Health.
- MD degrees at institutions including Yale University School of Medicine, Chicago School of Medicine, Columbia University Vagelos College of Physicians and Surgeons, Tufts University School of Medicine, McGill University.
- MD/PhD degrees at universities including the Albert Einstein College of Medicine, University of Connecticut.
- NIH Post-baccalaureate studies.
- Research fellowships/research assistant positions at institutions including Johns Hopkins Medical School, Harvard Medical School Harvard School of Public Health, Memorial Sloan Kettering Cancer Center, Skirball Institute NYU, and the National Institutes of Health.
- Business and Law school.
- Teaching at the elementary and secondary levels
- Science advocacy at non-profit organizations

Source: ASBMB

Student Groups

The Major Groove

ASBMB
American Society for Biochemistry and Molecular Biology
STUDENT CHAPTERS

The Major Groove is Wesleyan's official ASBMB (American Society for Biochemistry and Molecular Biology) student chapter. Students in the Major Groove are able to apply for ASBMB scholarships and research grants and access ASBMB resources to learn about career and internship opportunities and public policy initiatives.

On campus, the Major Groove organizes academic, social, and outreach events throughout the year. The Major Groove typically hosts welcome lunches, pre-registration events, and other gatherings for students in the major to get to know and support each other as they pursue the major. The group has also recently worked with Cardinal Kids (a teaching group organized by Wesleyan students) to plan science themed events at Wesleyan's R. J. Julia bookstore.

To learn more about the Major Groove or the ASBMB, contact Michelle Murolo (mmurolo@wesleyan.edu)

The Jelly Rolls

Wesleyan's Student Chapter of the Biophysical Society meets every other Friday during the academic year and hosts social and educational events throughout the year.

2022/23 Board Members

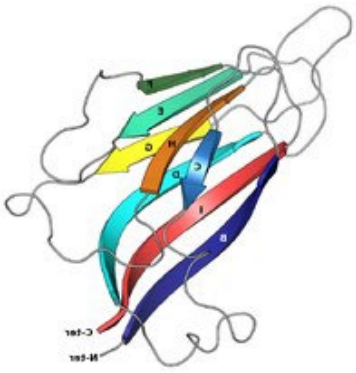
President: Julissa Cruz Bautista (jbautistacru@wesleyan.edu)

Vice President: Farah Hasanain (fhasanain@wesleyan.edu)

Secretary/Treasurer: Carolyn Sam (csam@wesleyan.edu)

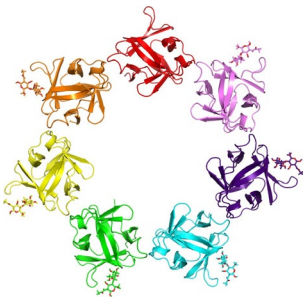
Chapter Sponsor: Candice Etson (cetson@wesleyan.edu)

The name of the group is an homage to the jelly roll fold protein.



A canonical example of a jelly roll viral capsid protein, from the satellite tobacco mosaic virus. The individual beta strands are labeled with their traditional designations (for historical reasons, sheet A is not used), highlighting the packing of the BIDG and CHEF four-stranded sheets.

The Molecular Biophysics Program



Molecular Biophysics Program Highlights

- Annual retreat with distinguished keynote speaker and student poster session
- Interactions with local and international biophysics groups
- All students are encouraged to join and attend meetings of the Biophysical Society
- Interdisciplinary connections across Wesleyan NSM

SACNAS

The Wesleyan SACNAS (Society for Advancement of Chicanos/Hispanics and Native Americans in Science) chapter is coordinated by Teresita Padilla-Benavides in the MB&B Department. Wesleyan SACNAS is dedicated to supporting diversity and inclusion in the sciences and fostering the success of underrepresented minorities in STEM.

Officers

President: Michael Quinteros '24

Co-Vice Presidents: Jocelyn Velasques-Baez '23, and Fa'alataitaua Fitisemanu '24

Treasurer: Imaru DiBartolomeo '25

Secretary: Joshua Grajales '24

National Liaison: Julissa Cruz Bautista '24

Contact Professor Padilla-Benavides (tpadillabena@wesleyan.edu) for more information and to join.