

Strategic Plan for Department of Integrative Biology

June 2019

STATEMENTS OF MISSION, VALUES, AND VISION

Mission

The mission of the Department of Integrative Biology is to advance understanding of the function, stability, resilience, and adaptation of complex biological systems in changing environments via research, teaching, and outreach. We do this from a position as national and global leaders in research and teaching that interrelates molecular, genetic, developmental, physiological, behavioral, ecological, and evolutionary processes.

Values

- Respect – We work together to create an environment free from discrimination and harassment, where people feel comfortable and are not threatened or intimidated, leading to a productive and creative community.
- Inclusiveness – We welcome and support people of all backgrounds and identities. This includes, but is not limited to, people of any sexual orientation, gender identity and expression, race, ethnicity, culture, national origin, social and economic class, educational level, color, immigration status, sex, age, size, family status, political belief, veteran status, religion, and mental and physical ability.
- Principled - We are committed to well-documented, replicable research and humane treatment of all research animals.
- Consideration - We depend on each other to produce our best work as a department. Politeness, kindness, attention to deadlines, and professionalism in communication help others produce their best work.
- Responsibility – We are accountable and keep commitments. We know our responsibilities as a faculty member, staff member, or student, and know where we can turn (or refer others) to get help.

Vision

The revolution in biological research and its application in ecology, medicine, agriculture and industry will provide a sustainable global environment with food, water, health, economic, and cultural security for a high quality of personal, family, and community life.

CODE OF ETHICS STATEMENT

BE INCLUSIVE

We welcome and support people of all backgrounds and identities. This includes, but is not limited to, people of any sexual orientation, gender identity and expression, race, ethnicity, culture, national origin, social and economic class, educational level, color, immigration status, sex, age, size, family status, political belief, veteran status, religion, and mental and physical ability.

BE CONSIDERATE

We depend on each other to produce the best work we can as a department. Politeness, kindness, attention to deadlines, and professionalism in communication help others produce their best work.

BE RESPECTFUL

We work together to create an environment free from discrimination and harassment, where people feel comfortable and are not threatened, leading to a productive and creative environment.

BE AWARE

We provide a safe, supportive work environment. All MSU employees, including faculty, staff, and students, are mandatory reporters, which means that if any of us hear about or observe Sexual Harassment or Violence (SHV) we are required to report to the Office of Institutional Equity (OIE).

BE PRINCIPLED

We are committed to well-documented, replicable research and humane treatment of all research animals.

BE INFORMED

We value personal responsibility: know your responsibilities as a faculty member, staff member, or student, and know where you can turn (or refer others) to get help. A list of resources is below.

These guidelines apply to the faculty, staff, and students in the IBIO department. If you feel these guidelines are not being followed, please consider discussing with your supervisor, the Graduate Director, the Faculty Advisory Committee, or the IBIO chairperson. Violations of these guidelines will be discussed as part of annual reviews and may be grounds for initiation of disciplinary action, termination of employment or forfeiture of stipends, fellowships, scholarships and awards.

EXECUTIVE SUMMARY

Introduction

Our mission is to advance understanding of the function, stability, resilience, and adaptation of complex biological systems in changing environments via research, teaching, and outreach, and to apply this understanding to the challenge of providing a sustainable global environment with food, water, health, economic, and cultural security for a high quality of personal, family, and community life.

We support a highly productive program with our faculty and staff, currently comprised by 28 Tenure Stream (TS) faculty with partial or full appointments in the unit (19.3 FTEs), 7 Fixed Term (FT) faculty (5.5 FTEs), and 2 Academic Specialists (2 FTEs). We rank highly in research and teaching within the College of Natural Sciences and nationally among peer departments in our research funding, Scholarly Research Index by Academic Analytics, and both graduate and undergraduate teaching. We are at or near the top of these rankings.

Diversity, Equity, and Inclusion

The Department of Integrative Biology (IBIO) includes and serves faculty, staff, and students from a wide range of cultural and professional backgrounds. We feel that diversity of perspectives strengthens our ability to advance science and enhances our ability to effectively serve our educational and research missions. IBIO is committed to fostering a diverse, equitable and inclusive workplace that enriches our learning environment and innovative research. We believe that a culture of diversity, equity and inclusion leads to new ways of thinking, behaving and caring.

We embrace the diversity of our department and community, including persons of varying age, disability, ethnicity, family status, sex, gender identity, geographic region, national origin, political affiliation, race, religion, sexual orientation, and socioeconomic status and other varied backgrounds and life experiences. Together with the College of Natural Sciences, we strive to recruit, retain, and develop a diverse group of individuals to ensure a vibrant community that promotes excellence in education and discovery at Michigan State University.

Research

Our department continues to evolve in parallel with biological research in the 21st century that is highly interdisciplinary and integrates across multiple scales of biological organization. Our research must serve national priorities related to sustainable biodiversity and its conservation, ecosystem services, as well as human and ecological health in a changing world. Uncovering the general ‘rules of life’ that span the entirety of biological organization – from genomes to organisms to entire ecosystems – and that

harness the 'Big Data' revolution, is a main focus of current and future multi-million dollar funding opportunities.

MSU IBIO is a leader in the biological revolution because of our unique, integrative approaches to questions concerning the response of complex biological systems to environmental change on multiple temporal and spatial scales. Through recent hires, we gained additional research strengths, particularly in areas that link genomic information to organismal diversity and in connecting organismal diversity to entire ecosystems. Leveraging these emerging assets along with our existing strengths, we are reorganizing our IBIO research agenda focusing on two main, cross-cutting research areas:

Research Area 1: Understanding Rules of Life to Connect Genomes to Organisms

Using the predictive power of big data, connecting the genome of an organism to its overall characteristics, or phenotype, is central to the mission of 21st century biology. Our next hire in this area will work on *Functional Evolutionary Genomics* and use functional genetic and developmental approaches to uncover the genetic and cellular mechanisms that link genome information to biodiversity.

Research Area 2: Understanding Rules of Life to Connect Organisms to the Biosphere

Connecting biological patterns and processes measured across scales ranging from individual organisms to ecosystems and even global scales is key to understanding the sustainability of ecosystems. Our next hire in this area will be in the emerging discipline of *Macrosystems Biology* that tackles questions regarding how individual organismal characteristics scale up to shape the dynamics of populations, communities, and entire ecosystems.

Future hires in our two research areas, together with improved research infrastructure, will create cross-cutting synergies with numerous other units at MSU; make us highly competitive for multi-million dollar collaborative grants (including training grants); and allow us to improve the preparedness of our graduates for a workforce that increasingly relies on interdisciplinarity and big data literacy.

Graduate Programs

IBIO has a highly productive and successful graduate program. We supervise more Ph.D. students per faculty member than any other biology department in CNS and our students successfully compete for more college and university-wide fellowships than any other department in CNS. We lead the EEBC graduate program, a highly successful interdisciplinary dual major graduate program. Our Ph.D. program is as productive as other highly ranked ecology and evolution program in the U.S.

Our main thrusts for improving our graduate program are obtaining extramurally funded graduate training programs, improving networking and diversifying career opportunities, and improving the quality of life and mental health of students.

Undergraduate Programs

We use our study of organisms and ecosystems to focus on understanding how biological systems develop, function, interact, and evolve in a complex and changing world. Our vision is based on the notion that by examining biological phenomena at all levels of the hierarchy of life in their ecological and evolutionary contexts, we can identify more purposeful questions and develop more meaningful answers.

We train our students for work on the front lines of the biological revolution, to serve national and global needs related to sustainable biodiversity, ecosystem services, and human and animal health and welfare in the face of changing environments. IBIO is unique in that we offer majors that provide a broad preparation for postgraduate education (IBIO) alongside more targeted degrees that prepare students for work in, for example, government agencies (Environmental Biology/Zoology) or zoological parks and aquariums (Zoology: Zoo and Aquarium Science). Building upon the strong foundation of our Zoology curriculum (e.g., Mammalogy, Comparative Anatomy, Developmental Biology), we are embarking upon a curricular review to fine-tune our degrees and highlight the talents and expertise of our newly hired faculty, bringing new foci to our study of 'life in context'. At the same time, we are instituting changes, like an orientation course for first-year students (IBIO 200 Animal Diversity) that will better prepare our students for their upper level classwork and their eventual career paths.

Post-doctoral Research Associate Program

Integrative Biology has an active post-doctoral research associate program with 22 post-doctoral fellows currently working with IBIO faculty. The number of post-docs has significantly increased in the past five years with increased funding of the new junior faculty.

IBIO has been working to include post-docs in departmental activities and to develop policies that will improve the quality of the MSU program and better serve post-docs. Post-docs have many of the same concerns as our graduate students about increased networking within and outside MSU for research collaborations, employment opportunities, and exposure to non-academic career routes. IBIO will work with the MSU Postdoctoral Office to help with post-doc needs. IBIO faculty supervising postdocs are encouraged to develop individual postdoc mentoring plans. As an orienting guide for starting post-docs, an IBIO post-doc handbook will be developed.

Resources

Budget cuts limit the ability of Integrative Biology to be entrepreneurial with new initiatives and faculty. More funds should come back to departments through earned

overhead return and online student tuition. The counter-productive and unfair end-dates on faculty start-up funds should be removed.

Future investments in faculty, particularly senior faculty are needed with retirement of senior faculty. One of the key investments is an extramural search for a departmental chair when Dr. Tom Getty retires.

STRATEGIC PLAN FOR DEPARTMENT OF INTEGRATIVE BIOLOGY

1. Introduction to the Department of Integrative Biology

The Department of Integrative Biology studies biological systems spanning the entirety of life at all levels of biological organization and ranging from molecules to entire ecosystems as they change over time scales ranging from milliseconds to millennia. Our work is guided by the understanding that evolutionary processes shape biological systems, their interactions, responses, resilience, stability, and health. We use cutting-edge tools to address important questions about genetics, development, physiology, behavior, ecology, and evolution in a wide array of organisms and systems, including digital organisms. We seek understanding of how complex biological systems, from gene networks to entire ecosystems, respond to environmental change with the goal of managing these dynamic systems to sustain human health and well-being. Our research serves state, national, and global needs related to sustainable biodiversity, ecosystem services, and human and animal health in a changing world.

We are currently 28 Tenure Stream (TS) faculty, 15 with 100% appointments in Integrative Biology, 10 with partial appointments ranging from 15% to 80%, and 3 with 0%. This equals 19.3 TS FTEs. We also have 7 Fixed Term (FT) faculty (5.5 FTEs) and 2 Academic Specialists (2 FTEs) who help support our substantial undergraduate teaching and advising efforts.

Our core goals are:

- To create a safe, friendly, welcoming environment for a wide diversity of students, faculty, staff, and our community;
- To be world leaders of research in integrative approaches for understanding biological systems in the face of environmental change;
- To be leaders in science education by continuing to support Biology Initiative efforts to design and deliver engaging and effective undergraduate education in biology;
- To strengthen and modernize teaching of undergraduate and graduate biology by: 1) integrating concepts at multiple levels of biological organization and systems thinking at the genomic, cellular, organismal, and ecosystems levels, and 2) providing students with the tools to develop statistical and computational skills;
- To recruit the most talented undergraduate students, graduate students, and post-docs and develop them into leaders in the private, public, and academic sectors;
- To relate our research to societal benefits, which is part of our mission, important for long-term strategies for grant support, and contributes to public support for science.

Our research on complex biological systems, ranging from molecules to ecosystems, clusters in two research areas based on analytical methods and conceptual approaches: 1) **Understanding Rules of Life to Connect Genomes to Phenotypes** and 2) **Understanding Rules of Life to Connect Organisms to the**

Biosphere. The first research area addresses genetic and environmental processes that influence the emergence of phenotypic complexity, not only during embryological and later ontogenetic development, but also over ecological and evolutionary time scales. We address questions in biology related to the origins of biodiversity, the coordination of development from embryo to adult to produce an appropriately integrated organism, and how development enables adaptive responses to some environmental changes but results in malformation and disease in others. Additional questions concern the phenotypic plasticity of organisms, the genetic and cellular dynamics underlying normal physiological and behavioral processes and disease states, and the dynamics of information processing in the bodies and brains of organisms. The second research area addresses how biological systems respond to environmental change on ecological and evolutionary time scales. The latter area addresses broad questions in biology concerning the distribution and abundance of organisms, the genetic and environmental basis of diverse morphologies, behaviors, and survival strategies, interactions between organisms and their abiotic environment, the ecological and evolutionary dynamics of populations and communities, and the coupling between human and natural ecosystems.

Within each of these research areas, we are developing focal areas to target advancements on research themes that will be important for solving problems in the biological revolution, supporting human well-being, and generating demand for research funding.

Within the research area for **Understanding Rules of Life to Connect Genomes to Organisms**, our plan is to develop a focal area in **Functional Evolutionary Genomics**. Functional genomics aims to develop a mechanistic understanding of the causal molecular, cellular, and developmental paths that generate new phenotypes from genomic variation. We plan to recruit new faculty that use functional genetic and developmental approaches (genome editing, high resolution imaging, etc.) will focus - within an evolutionary framework - on the genetic and cellular mechanisms that link genotypic to phenotypic variation, and more generally to biodiversity.

Within the research area **Understanding Rules of Life to Connect Organisms to the Biosphere**, our focal area for advancement is **Macrosystems Biology**. Macrosystems biology is an emerging discipline within ecology that tackles questions regarding how individual traits or processes scale up to shape the dynamics of populations, communities, and entire ecosystems. We plan to recruit new faculty to bring modern approaches that permit use of massive datasets and will address ecological problems that play out over long time periods and regional to continental scales. These questions extend beyond basic biology and to applied ecology and environmental management.

Our unique strength is an integrative approach to complex biological systems in changing environments. This overarching focus guides our research, and forms the foundation for our popular undergraduate majors, a high-impact graduate program, and

outreach efforts associated with BEACON, GK-12, LTER, GLBRC, the MSU Museum, government agencies, and various ad hoc initiatives. Integrative Biology plays a critical role in the undergraduate curriculum in CNS and at MSU, and we have played a leading role in the Biology Initiative to revamp the core biology curriculum. We provide required and recommended classes and lab experiences for pre-medical and pre-veterinary programs and the undergraduate neuroscience program. We are national and world leaders in research and application of our knowledge in environmental management.

We are performance leaders within CNS and outside MSU among our peer departments. According to 2018-2019 OPB statistics (Table 1), our grant funding per FTE (tenure stream FTEs only) is as high or higher than any biology unit in CNS, other than Plant Biology and Neurobiology. Our student credit hours and tuition per FTE (tenure stream and fixed term FTEs) are more than 25% higher than any other biology unit in CNS and 2 times higher than the unit average in CNS. Our combined Grant Funding and Tuition per FTE is also higher than any other biology unit in CNS. Our Academic Analytics Scholarly Research Index (SRI), 85.7, is higher than all biology units in CNS, except for the 88.6 for Plant Biology (Table 2). We rank 3rd among our disciplinary peer group in SRI. Our high SRI scores were most related to high performance in citations for our research, but all categories of metrics scores were well above the median among our peer departments (Figure 1). According to a 2010 report by the National Research Council, our graduate program produced as many Ph.D. students per faculty member (FTE) as ecology programs at Harvard and UC Berkeley, and more than other Big Ten universities (Table 3).

2. Diversity, Equity, and Inclusion

Diversity, Equity and Inclusion (DEI) Statement: The Department of Integrative Biology (IBIO) includes and serves faculty, staff, and students from a wide range of cultural and professional backgrounds. We feel that diversity of perspectives strengthens our ability to advance science and enhances our ability to effectively serve our educational and research missions. IBIO is committed to fostering a diverse, equitable and inclusive workplace that enriches our learning environment and innovative research. We believe that a culture of diversity, equity and inclusion leads to new ways of thinking, behaving and caring.

We embrace the diversity of our department and community, including persons of varying age, disability, ethnicity, family status, sex, gender identity, geographic region, national origin, political affiliation, race, religion, sexual orientation, and socioeconomic status and other varied backgrounds and life experiences. Together with the College of Natural Sciences, we strive to recruit, retain, and develop a diverse group of individuals to ensure a vibrant community that promotes excellence in education and discovery at Michigan State University.

- ❖ **Where we are ...**
- **Where we are going ...**

- ❖ **IBIO Diversity, Equity and Inclusion Committee (DEIC)**

The department has formed an IBIO Diversity, Equity and Inclusion Committee (DEIC). DEIC is charged with recommending and reviewing initiatives, policies and programs that support or increased equity, diversity, and inclusion throughout our department's community. It will also collect and disseminate DEI resources through the departmental website.

The DEIC is currently composed of at least 2 faculty (1 Tenure-stream faculty/TSF and 1 Fix-term faculty/FTF), 1 staff, 1 academic specialist, 1 undergraduate student, 1 graduate student and 1 post-doctoral associate. Each member will serve terms with a minimum of two and maximum of three-years.

Identifying and addressing DEI efforts to:

1. Promote a diverse, equitable and inclusive **faculty** (TSF and FTF),
 - Identify and implement strategies to increase the diversity of the faculty
 - Monitor the diversity of the faculty, including **recruitment, hiring, retention, and promotion**
 - ❖ Proposed guideline suggestions for **Faculty Hires** that reflect our DEI stance, including (but not be limited to):
 - Tailor positions to cover broader areas to attract a more diverse applicant pool whenever possible.
 - Add a specific statement in the job ad indicating IBIO's commitment to diversity (beyond what's already required by the University)
 - Require a diversity statement from applicants to demonstrate commitment
 - Request submission of 1 key research article that illustrates best their strengths in order to focus on caliber & potential and not quantity of work.
 - Purposely reach out to qualified applicants in underrepresented groups to encourage them to apply as an extremely powerful and effective method for recruiting.
 - Train for members of search committees in DEI issues.
 - Diversify advertising tactics to specifically reach underrepresented groups (list serves and partnerships such as ESA SEEDS board, and others)

2. Promote a diverse and inclusive **Staff**.
 - Identify and implement strategies to increase the diversity of the staff.
 - Monitor the diversity of the staff, including **recruitment, hiring, retention, and promotion**.
3. Promote a diverse and inclusive **Academic Specialist**.
 - Identify and implement strategies to increase the diversity of academic specialists.
 - Monitor the diversity of the staff, including **recruitment, hiring, retention, and promotion**.
 - Strictly follow the University's protocols for reappointment, continuing status, and promotion
 - Require academic specialists who are academic advisors to complete the three part Implicit Bias/Microaggressions Training provided by Michigan State University
 - Proposed guideline suggestions for **Academic Specialist Hires** that reflect our DEI stance, including (but not be limited to):
 - Adding a specific statement in the job ad indicating IBIO's commitment to diversity (beyond what's already required by the University)
 - Requiring a diversity statement from applicants to demonstrate commitment
 - Training for members of search committees in DEI issues.
 - Broader advertising tactics to specifically reach underrepresented groups
 - ❖ Academic specialists can serve on standing and ad hoc committees
4. Facilitate and implement **professional development activities** that actively engage **faculty, staff** and **academic specialist** in work practices that address issues of diversity, inclusion, and equity.
 - ❖ Compile a list of existing University wide resources that already exist to start addressing such issues, such as seminars, training and workshops such as:
 - Diversifying and Retaining Faculty and Staff
 - Building an Inclusive Workplace
 - Disrupting Bias in the Academy
 - Introduction to Implicit Bias and Microaggressions
 - ❖ IBIO is cognizant that FTF, staff & academic specialists need to have broader representation within IBIO affairs such as departmental committees, voting rights, ability to serve as chair of a

standing or ad hoc committee (appointed by the chairperson), and activities.

- ❖ Equity in regards to time allotments and funding that allow for implementation of developmental activities needs to be addressed.
5. Promote a diverse, equitable and inclusive **undergraduate student body**.
- Identify and implement strategies to increase the equity & diversity of undergraduate students.
 - AN IBIO Undergraduate Awards Committee was established in 2018 to ensure equitable selection of IBIO undergraduate award winners
 - Equitable selection of the Nat Sci Student Advisory Council representative for the Department of Integrative Biology
 - Select an undergraduate IBIO representative to attend the Department Meetings and have undergraduates serve on other committees.
 - Communication materials portray a diverse array of undergraduate students whenever possible
 - All undergraduate students have equal access to resources
 - Engage Dow Stem Scholars, Drew Scholars, Emerging Scholars
 - Appoint diverse representative of the student body for department promotional events (e.g., colloquium)
 - Advance equity/diversity statements in undergraduate lab assistant positions
 - Improving accessibility to core resources thus ensuring that all undergraduate students are equal and full participants in the college experience
 - Monitor the diversity of the student body, including **admission, enrollment, retention, and graduation**.
 - Create a sense of IBIO community amongst undergraduates
 - Formulating and implementing strategies to address **DEI in the Classroom**.
 - Requiring all instructors to take DEI training
 - Fostering inclusive teaching practices to create inclusive lecture and laboratory settings in order to generate a stronger, more equitable community
 - Enhancing web-based student accessibility and productivity
 - Improving accessibility to instructors and teaching facilities to ensure that all students are equal and full participants in the college experience

- Developing mentoring programs for incoming freshman students by partnering with juniors; paying close attention to those from underrepresented groups.
 - ❖ Exploring strategies to address **DEI in Research**
 - Improving accessibility of underrepresented minorities to undergraduate research opportunities.
 - Developing research mentoring programs.
 - SCRUP program
 - Drew Scholar Program
 - Emerging Scholars program
6. Promote a diverse, equitable and inclusive **graduate student body**.
- Identify and implement strategies to increase the equity & diversity of students.
 - Monitor the diversity of the student body, including **admission, enrollment, retention, and graduation**.
 - ❖ Applicable strategies to address **DEI**:
 - Requiring all TA to take DEI training
 - Fostering inclusive research practices to create an inclusive laboratory environment in order to generate a stronger, more equitable graduate community
 - Improving accessibility to core resources thus ensuring that all graduate students are equal and full participants in the college experience
 - Improving mentoring of incoming graduate students; paying close attention to those from underrepresented groups
 - Establish research mentoring program outside of PI
 - Set up clear frameworks for equitable, constructive and timely feedback between graduate students and their PIs and/or graduate committees.
 - Travel Scholarships.
7. Promote a diverse and inclusive **Post-doctoral Fellows**.
- Identify and implement strategies to increase the diversity of academic specialists.
 - Monitor the diversity of the staff, including **recruitment, hiring, retention, and promotion**.
8. Develop and implement professional development activities that actively engage faculty and students in **research and teaching practices** that address issues of diversity, equity, and inclusion.

9. Systematically explore, and as necessary, propose policy that promotes positive well-being of IBIO faculty, staff, and students at large (**Campus Climate**).

3. Research Programs

External Factors

Biology has undergone a revolution over the past half century, moving from a set of disciplines organized around organismal (taxonomic) groups to an integrated, interdisciplinary array of research fronts focused on phenomena spanning the multiple levels of biological organization that exist within and among traditional taxonomic groups.

Our research needs to serve national priorities related to sustainable biodiversity and its conservation, ecosystem services, as well as human and ecological health in a changing world. If we hope to manage these dynamic systems to sustain human health and well-being, we need to understand how complex biological systems will respond to environmental change.

Uncovering the general ‘rules of life’ that span the entirety of biological organization – from gene networks to organisms to entire ecosystems – informed by the availability by the ‘Big Data’ revolution, is a main focus of current and future multimillion funding opportunities from NSF, NIH, USDA, DOE and others.

Current NIH and NSF strategic plans prioritize funding into utilizing the predictive power of Big Data to connect complex biological patterns and processes measured across scales ranging from genetic networks to individual organisms to ecosystems and global scales. This is key to understanding the consequences of genetic differences and environmental influences on organismal diversity and well-being, to informing management and conservation efforts for biodiversity and to ensure the sustainability of ecosystems.

Funding priorities call for the development and use of novel biological, theoretical, and quantitative approaches as well as functional experimental methods to investigate complex biological systems such as the interaction of the environment with an individual’s genome and interactions among organisms. Current and emerging strengths of MSU Integrative Biology research and our investigative focus areas perfectly align with major funding opportunities as described further below.

Internal Factors

The unique strength of MSU IBIO is an integrative approach to questions concerning the response of complex biological systems to environmental change on multiple temporal and spatial scales. Our work is guided by the understanding that evolutionary processes shape biological systems, their interactions, responses, resilience, stability, and health. The goal of 'Integrative Biology' is to incorporate a variety of biological disciplines (e.g. ecology, evolution, genetics, developmental biology, behavior, neurobiology) and levels of organization, from molecules through organisms to ecosystems, to understand biological phenomena in context and uncovering the 'rules of life'. Our department is united in a philosophy that draws on many disciplinary strengths to gain deeper insights into biological problems than are possible through organism-specific (e.g., zoology) or 'scale-specific' (e.g., laboratory, single habitat, regional, and global) approaches.

A major goal of our department is to achieve international leadership status. Through a string of recent hires, the department gained new research strengths particularly in two research areas of Integrative Biology:

1. Connecting genomic information to organismal diversity to understand the causes of biodiversity (recent faculty hires: Braasch, Bradburd, Evans, Fitzpatrick, Gallant, Ganz, Hintze, Meek)
2. Connecting organismal diversity to ecosystems to understand the consequences of biodiversity (recent faculty hires: Evans, Fitzpatrick, Haddad, Meek, Zipkin)

Our recent hires have positioned us to make revolutionary advances and create exciting new opportunities to address important biological questions.

Strategic Plan for Research

We are strengthening IBIO through reorganizing our research foci into two broad areas of biological processes:

- **Research Area 1: Understanding Rules of Life to Connect Genomes to Organisms**
- **Research Area 2: Understanding Rules of Life to Connect Organisms to the Biosphere**

Conceptually linking our research under these topics better unifies our efforts and provides for greater comparison across types of organisms (microbes to hyenas to humans) and biological processes occurring at different spatial and temporal scales (from molecules to individual behaviors to ecosystem level responses). Reorganizing our research foci under these themes provides for better collaboration among our faculty and progress toward our long term goals.

Future hires in these two areas will create cross-cutting synergies with numerous other units at MSU. The hires will make us more competitive for large grants, including training grants from NIH and NSF. In addition, these hires will allow us to increase the preparedness of our graduates for a workforce that increasingly relies on interdisciplinarity and big data literacy.

Research Area 1: Understanding Rules of Life to Connect Genomes to Organisms

Connecting the genome, or genotype, of an organism to its overall characteristics, or phenotype, is central to the mission of the National Institutes of Health and one of the '10 Big Ideas' of the National Science Foundation.

With the ever-increasing mountain of genomic data being generated using next generation sequencing, extraordinary strides in documenting genomic diversity across thousands of species are being made: we are entering an era in which genome sequences will be readily available for any given organism.

The explanatory power of the genome is just beginning to be harnessed. The wealth of genomic data, coupled with the revolution in genome-editing technologies such as CRISPR and the advances in high-throughput phenotype analyses ('phenomics'), allows us to move beyond genome sequences and their correlations to phenotypes. This facilitates a revolution in the effort to both quantify and functionally investigate the mechanisms and processes that generate phenotypic variation in populations, across species and higher levels of biological organization, as well as in human and animal health vs. disease.

In the face of global change, it is critical that we develop an understanding of developmental plasticity and epigenetic control of phenotypes under the influence of varying environments. MSU IBIO is poised to be a leader in developing – from evolutionary and ecological perspectives – a functional, mechanistic understanding of the molecular, cellular, and developmental paths that generate new phenotypes from genomic variation. IBIO is primed to experiment with and discover the causal relationships between genomes and organisms; we are perfectly placed for mechanistic genome function analyses (CRISPR genome editing, transgenics, etc.) in non-traditional model organisms with an evolutionary and ecological focus. Our research represents all domains of biodiversity (microorganisms, plants, animals, human health, as well as digital organisms and artificial intelligence), positioning us at the forefront of integrating genomic with phenotype data at multiple scales of biological organization as well as using a broad variety of model organisms of biomedical, evolutionary, ecological, and economic significance.

Future Faculty Hires. IBIO's newly gained strengths in evolutionary genomics research through recent new hires calls for sustained growth in the area of linking genomes to organismal diversity. We thus plan to focus our first new hire in Research Area 1 on the cross-cutting theme of **Functional Evolutionary Genomics**. This topic bridges

research from genetic and molecular scales to organismal development and then to the impact of environmental influences on organismal diversity and human and animal fitness and health.

We propose to hire a new faculty member whose research agenda uses functional genetic and developmental approaches to focus on the genetic and cellular mechanisms that links genome information to biodiversity. We envision a new faculty member who will bring and combine novel approaches such as CRISPR genome-editing and single cell-level sequence analyses. We will then have a complete team of faculty who can collaborate to test predictions derived from large-scale genomic and phenotypic data sets to better understand the evolutionary processes that have shaped organismal diversity and predict how ecosystems will react to changing environments in the future.

This topic will be highly competitive for multimillion NIH and NSF funding focusing on genotype to phenotype connections, such as the NIH Comparative Genomics Research Program, NIH-wide initiatives for single cell approaches and personalized medicine, the BRAIN Initiative, NSF's Rules of Life program, the NSF Enabling Discovery through Genomic Tools (EDGE) programs, and others.

Key opportunities for new cross-unit and cross college collaborations. Expanding IBIO research in the area of linking genomes to organismal diversity will readily generate synergies with numerous research groups within IBIO and will connect IBIO to functional and computational genomics and system biology research in other MSU units such as BMB, PLB, MMG, CMSE, Animal Science, and FW. IBIO research thereby links traditional laboratory model system-based projects (e.g. human cell lines, mouse, fly, etc.) with “real world” systems under natural conditions and “evolutionary mutant models” for human disease (i.e. organismal adaptations that resemble human disease states), extending to environmental influences and consequences of evolutionarily relevant genomic changes.

New training programs. Combining teaching modules in evolutionary biology with computational biology/bioinformatics, quantitative genetics, and functional genetic experimentation, new faculty members will create novel training grants and opportunities for postdocs, graduate students, and advanced undergraduates focusing on interdisciplinary approaches, new methods, and the use of ‘Big Data’. We will build on the experience of IBIO faculty in critically contributing to the success of NSF BEACON Center as a model for synergistic and interdisciplinary combination of evolutionary and computational approaches.

Facilities and Resources. With our increased investment in molecular-genetic infrastructure to tackle the functional genomic underpinnings of the genotype-to-phenotype map, generating spatially clustered laboratories within modernized space will

allow us to share personnel, facilities, computational resources, and equipment in innovative, cost-saving, redundancy-reducing operations and will develop networks of collaborations and research synergies.

Research Area 2: Understanding Rules of Life to Connect Organisms to the Biosphere

Connecting biological patterns and processes measured across scales ranging from individual organisms to ecosystems and even global scales is key to understanding the sustainability of ecosystems. It is also a growing research focus of NSF, as exemplified by their multi-billion dollar investment in the National Environmental Observatory Network (NEON) (see below). NSF encapsulates the integrative nature of this research area within the domain of Macrosystems Biology. This emerging discipline within ecology tackles questions regarding how individual traits or processes scale up to shape the dynamics of populations, communities, and entire ecosystems. The diverse research domain of Macrosystems Biology and the enormous research scales it spans are now possible because modern approaches permit use of massive datasets, allowing scientists to address ecological problems that play out over long time periods and at continental and global scales.

MSU IBIO is poised to advance knowledge on this frontier. We have a strong history of success in laboratory and field research for characterizing the ecology, evolution, and behavior of a broad diversity of organisms and types of ecosystems. This work provides a complementary basis for advancing the rules of life with new, modern tools and data sources, such as advanced telemetric monitoring, remotely sensed data, high-performance computing, and data collection by citizen scientists. Building strength in basic biology, an expanded focus in Macrosystems Biology at MSU, will position us to address the critical issues of our time in applied ecology. For example, a new hire occupying this conceptual domain could address problems such as the evolutionary ecology of disease, the spread of invasive species, ecological impacts of climate change, consequences of defaunation, or adaptation in the Anthropocene era. They could leverage existing resources such as our KBS - Long-Term Ecological Research program, to connect the LTERs experimental/mechanistic data with NEONS large scale monitoring data.

Beyond capitalizing on MSU's and Integrative Biology's existing strengths in this area, we are motivated by our aspiration to increase our competitiveness for the single biggest investment by NSF, NEON (The National Ecological Observatory Network). NSF's allocations to date of \$500 million is not a one-off investment; the NEON program will be a significant funding source for at least 30 years and the projected total investment by NSF is currently \$2.6 billion. As NEON is designed to collect and provide open data that characterize and quantify complex, rapidly changing ecological processes across the US, the comprehensive data, spatial extent and remote sensing

technology provided by NEON will enable MSU to tackle new questions at scales not accessible to previous generations of scientists.

Future Faculty Hires. We plan to focus our first new hire in Research Area 2 on the cross-cutting theme of **Macrosystems Ecology** which calls for integration of disciplines across Integrative Biology, Plant Biology, Microbiology, Climatology, and Earth and Environmental Sciences to understand and predict ecosystem response to natural and human disturbance. The biological components of this research call on Macrosystems Biology, spanning genes-to-biosphere, to understand eco-evolutionary processes as well as the coupling of organisms to ecosystems. The ecosystems can be natural or human-dominated by agriculture, forestry, or urban development. The abiotic components are the geology, climate, weather, hydrology, and soils that regulate biological responses. Big data collection, management, processing and application are used in Macrosystems Ecology to characterize ecological patterns, infer processes and then model ecosystems at scales ranging from a small plot in a field to the biosphere.

New hires in Macrosystems Ecology, by themselves and in collaboration with our existing faculty, will enable advances in studies of a new set of exciting problems that can be addressed with ‘big data’. Integrative Biology and other departments across campus already host faculty who are internationally recognized in Macrosystems Biology. A new hire with the expertise to link individual organisms to ecosystem-level processes would unite current MSU faculty who have expertise in either individual- or ecosystem-level phenomena, and provide MSU with the ‘critical mass’ needed to secure multi-million dollar collaborative grants. They will also fill critical gaps in our ability to train undergraduate and graduate students for the next generation of approaches needed to advance basic and applied ecology from local to global scales.

Key opportunities for new cross-unit and cross college collaborations. MSU biologists and fellow researchers in the natural sciences have a great history of working across disciplines with geologists, hydrologists, climatologists, and geographers. MSU’s cross-unit collaborations in teaching and research are exemplified by numerous highly successful programs in Macrosystems Ecology: cross-college programs such as EEBB, ESPP, and Spatial Ecology; interdisciplinary research centers such as the Center for Global Change and Earth Observations and the new Center for Interdisciplinarity; and three-decades of NSF support for the Kellogg Biological Station Long-Term Ecological Research program. As a sign of MSU’s position of strength in Macrosystems Ecology, we already have the highest density of PIs with past and current awards from an NSF program named Macrosystems Biology (7 active awards totaling over \$7 million). These faculty represent five departments in four colleges. Our stature in this area is significant, as Macrosystems Biology is the predecessor to NEON funding, exemplified by the active NSF solicitation being called “Macrosystems Biology and NEON-Enabled

Science (MSB-NES)". Currently, there are at least 12 MSU faculty using NEON data, likely more than any other university as this is only the first year of all sites being fully operational. A new hire would consolidate and project strength in this emerging programmatic focus.

Another of MSU's strengths is the linkage between natural sciences, social sciences, and policy as demonstrated by MSU's great success with NSF's program, INFEWS (Innovations at the Nexus of Food, Energy and Water Systems). A broader partnership among natural scientists with macrosystems biologists brings together two great strengths at MSU that address important problems.

New training programs. Faculty at MSU are in a unique position to lead MSU graduate training in Macrosystems Biology, including National Research Traineeship (NRT) grants and others from NSF, USDA, and NASA. We have a critical mass of scholars leading successful macrosystems research programs.

Facilities and Resources. Because of our focus from genes to ecosystems, Integrative Biology is positioned to be a focal department and a cohesive unit for Macrosystems Biology. A new hire would provide cohesion to cross-unit efforts. Elevated stature to this area at MSU will allow students and faculty to leverage the intense and novel data needed to fulfill the promise of connecting organisms to the biosphere.

DEI in Research

IBIO is committed to fostering a diverse, equitable, and inclusive workplace that enriches our research. We believe a culture of diversity, equity, and inclusion leads to new ways of behaving, caring, interacting, and thinking. Advancing our innovative areas of research will provide an opportunity to recruit, retain, and develop a diverse group of individuals to ensure a vibrant community that promotes discovery at MSU. Our plans for DEI training, a DEI culture, laboratory clusters, and networking also provide new opportunities for enhancing diversity, equity and inclusion in IBIO.

We are currently revising guidelines for future faculty hires that reflect our DEI stance, including (but not limited to):

- Tailoring positions to cover broader areas to attract a more diverse applicant pool.
- Adding a specific statement in the job advertisement indicating IBIO's commitment to diversity.
- Requiring a diversity statement from applicants demonstrating commitment to DEI.

- Requesting submission of a key publication that illustrates best the applicant's strength in order to focus on caliber and potential and not quantity of work.
- Broader advertising tactics with a goal of reaching qualified applicants specifically from underrepresented groups.
- Training of search committee members in DEI issues.

Regarding our training efforts, we are developing specific DEI guidelines including (but not limited to):

- Develop and implement professional activities that actively engage faculty and students in research and teaching practices that address issues of diversity, equity, and inclusion.
- Requiring all instructors and TAs to take DEI training.
- Improving accessibility of underrepresented minorities to student research opportunities.
- Developing research mentoring programs for undergraduates and establishing mentoring programs for graduate students outside their PI.

4. Graduate Programs

Introduction

At the graduate level, we have a large and successful program. We currently have 43 doctoral students and 6 MS students. Our PhD program is among the largest of CNS biology units in terms of the number of doctoral students, and the largest in terms of the number of doctoral students per FTE faculty member (2.3 students/FTE). Over the past 15 years, we have consistently recruited and supported a disproportionate share of NSF, UDF and CNS fellowship awardees in CNS. Of 38 students who received PhDs from 2014-2019, 10 were supported by NSF Graduate Research Fellowship awards, and 15 received College or University recruiting fellowships. Our graduate students also have received EPA -STAR, Fulbright, and PEO Sisterhood Fellowship awards. Of the 38 PhD graduates we have tracked, 5 are now in industry, 18 are in postdoctoral positions and 5 hold faculty positions. In addition to these PhD graduates, 9 students have been awarded Masters degrees and moved into professions or PhD programs. Our students' research output has also been impressive. Since 2014, our 38 PhD graduates cumulatively published 151 papers based on their graduate work (average 4.1 papers per PhD graduate), and 273 total papers across their careers to date (average 7.4 total papers per person).

DEI. Women represent almost half of our PhD alumni since 2014 (18/38) and 63% of our current PhD students. Our efforts to recruit under-represented minorities has paid

off in the past five years. Students from underrepresented groups now constitute 16% of our PhD students, as compared with 2% in 2013. We will continue to work with the Graduate School and their programs, as well as CNS and BEACON Diversity staff to find ways to increase our success.

Interdisciplinary programs. The strength of our program arises in large measure from the leading role that Integrative Biology faculty members have played in several interdepartmental graduate training programs and projects -- especially EEBB and BEACON, but also Genetics, Neuroscience, ESPP, and Cognitive Science. The Director of EEBB is currently Kay Holekamp, and in fact all previous directors of EEBB have been members of this department, attesting to the central role that EEBB plays in our graduate training. Integrative Biology faculty members teach or co-teach ~2/3 of EEBB core courses, and serve on or chair all the EEBB advisory committees. Furthermore, IBIO faculty members have played key leadership roles in major research and training initiatives, including the GK-12 sustainability projects at KBS from 2004-2016 (T. Getty, PI), the NSF-funded KBS LTER (Long-Term Ecological Research) Site (N. Haddad, Director), the DOE Great Lakes Bioenergy Research Center (N. Ostrom, participating research faculty), and especially the NSF BEACON Center for the Study of Evolution in Action, which will complete 10 years of funding in 2020.

BEACON deserves special discussion because it reflects on the leadership role played by IBIO in this important research area, and because it has had such a big impact on graduate and postdoctoral training in the department. IBIO faculty members serving as leaders in BEACON include K. Holekamp and R. Lenski (who are co-PIs of the BEACON); T. Getty (Director of BEACON's Education and Human Resource Development programs); and F. Dyer (senior personnel on the BEACON grant and co-lead of BEACON Thrust Group 3: Communities and Ecosystems). As many as fifteen other IBIO faculty members are also active members of the BEACON Center.

One of our strategies for engaging graduate students in interdepartmental programs is the low number of required courses for a doctoral degree in IBIO. We assign the responsibility of developing rigorous and personalized graduate programs to the graduate students themselves and the graduate student's committee.

Internal Factors

IBIO/ZOL has traditionally maintained a high capacity to support students on Teaching Assistantships, Internal Fellowships and Research Assistantships through individual faculty grants. We have benefited particularly in recent years from having significant support from federally funded training initiatives, including the BEACON STC from 2010-2010 and the NSF GK-12 program at KBS from 2006-2016. Of our 38 PhD graduates from 2014-2019, 13 received at least one semester of support from either

BEACON or GK12 funds, with an average of 2.8 semesters of support per student receiving these funds. BEACON had an especially big impact on IBIO because so many of our faculty members (>15) participated in BEACON, and received research awards that supported students or postdocs. BEACON is in its last year of NSF funding. Although the Center will continue for a few years, and will continue to fund graduate training, the amount of funds will be reduced. A renewal proposal for BEACON is planned with an emphasis on engineering via “applied evolution.” Other STC proposals are also planned for the Ecology of Infectious Disease and Macrosystems Ecology. So, possibilities of future STC funding for graduate student research may develop. Another change in our capacity has been a reduction in the number of TA slots that we have available to support students. In comparison other departments, IBIO has maintained an undergraduate curriculum with a rich diversity of lab and writing-intensive courses, and a pool of TA money to support this curriculum. Budget cuts have lowered our capacity to support students on TA funds from about 25 per year to about 20 per year (Figure 2).

Training experience. Graduate students describe the IBIO graduate experience positively for it being interdisciplinary, flexible, offering strong quantitative skills and curriculum, and supporting mentorship, providing exposure to leaders in their fields, and providing a safe and friendly atmosphere. They also highlight issues that could make the program more effective. Graduate students would like faculty and the IBIO Department to promote mental health and well-being of students through proactive organization and management of their programs. Non-academic careers are becoming a greater interest for graduate students. We should develop methods to help them explore, train for, and land careers with government and non-government organizations, industry, and consulting firms.

Strategic Plan for Graduate Programs

New Research and Graduate Training Initiatives. One of our major goals is to develop new research, graduate training and undergraduate training initiatives focused on looming national needs. In the process, we need to improve training in quantitative and computational skills at all levels. If we take increasing responsibility for the undergraduate students currently in the Human Biology program, we will be able to tap into educational funding resources available at NSF & HHMI in training future biomedical professionals to harness the power of evolutionary ecology in their diagnosis and treatment of human and animal disease. Integrative Biology faculty already play leading roles in graduate training at MSU and recruitment of new faculty further improve our graduate training program by increasing the critical mass of research and expertise in our new research focal areas.

Mental Health and Quality of Life. We plan to develop a committee of faculty, post-doc, and graduate students to determine threats to graduate student and post-doc mental health and quality of life and to design and implement a strategy for improvement. We will engage the graduate school to determine university and extramural resources to improve and sustain mental health and quality of life. In particular, the committee will be tasked to review goals and recommendations for comprehensive exams. In addition, the committee will review the Guide to Graduate Study in Integrative Biology (<https://integrativebiology.natsci.msu.edu/graduate-program/guide-to-graduate-study-in-integrative-biology/>) to determine gaps, needed updates and methods for making this detailed document more useful. Updates should be considered for annual report procedures, timelines and goals, and strategies for developing research ideas.

Networking To Improve Research Quality and Career Opportunities. We have recently started a departmental seminar program to improve networking among faculty and graduate students in the department. The first year of these seminars was very successful and we plan to continue. These seminars provide an opportunity to invite speakers (colleagues and alumni) from government (federal, state, and local), non-profit organizations, consulting, and industry to increase networking and exposure of graduate students and post-doctoral students to non-academic careers. Faculty will also be encouraged to invite non-academic speakers for class lectures. Faculty will be encouraged to target efforts to enhance networking of our graduate students at professional meetings. Alumni networking strategies will also be explored and implemented.

The department will review a diversity of other strategies to improve graduate student experience, particularly for networking: a departmental retreat, common core courses, meeting spaces for graduate students and post-docs, and peer-to-peer mentoring.

Small funding provides big advantages for graduate students. We plan to encourage and facilitate graduate student applications for extramural funding to provide them with the experience and track-record for funding and the actual funds for their research.

Re-envisioning Graduate Programs and Defining Success. Given the diversity of students and career options, traditional approaches to graduate programs will not help all students best utilize their talents and achieve their goals. We will revisit the goals of graduate training in IBIO with a focus on future needs in ecology, medicine, agriculture, industry, and society. We will ensure use of evidence-based teaching, training, and mentoring practices that promote the development of trainees from all backgrounds. We plan to revisit our requirements for graduate programs to increase flexibility in requirements and thereby accommodate and encourage a greater diversity of students and their goals.

In addition, we plan to encourage and facilitate service and outreach by graduate students to the local community and their future professions. This will involve some changes in expectations for defining success by graduate students.

We plan to explore internship opportunities for graduate students with an emphasis on non-academic experiences. This will increase exposure to non-academic careers, networking with the community, and chances for employment.

We plan to explore more technical and professional training opportunities for graduate programs. For example, partnerships between CNS biology programs and CMSE are producing short courses genomics training. The idea of using more modular versus full courses will be investigated and incorporated into graduate student programs.

Taking Advantage of the MSU Graduate School Experience and Resources. The Graduate School at MSU provides a common resource for all MSU graduate programs. The Grad School's Research Integrity Program is an excellent example of a resource that benefits the IBIO graduate program as well as others. The Graduate School recently developed a strategic plan (<https://grad.msu.edu/strategicplan>). Key goals of that plan are student success, diverse and inclusive communities, and interconnectedness. These key goals are strategic priorities for the IBIO graduate program. Aligning IBIO's plans with the Graduate School will help us achieve our goals more effectively.

5. Undergraduate Programs

Background

Teaching and Education. The undergraduate degree programs of the Department of Integrative Biology are designed to allow students to acquire biological understanding in the core conceptual areas of biology: evolution, structure and function, information transfer and gene expression, transfer of matter and energy, and organismal and systems biology. We offer four undergraduate degrees and several concentrations to facilitate tailoring coursework to align with individual interests and career aspirations. Our degrees prepare students for graduate/professional schools or to enter the job market. Overlap among our degrees allows for easy transition from one track to another as student career goals change and mature.

Characterization of the Integrative Biology Undergraduate Program. IBIO embraces the following core competencies outlined in Vision and Change (AAAS, 2009) in our undergraduate programs: 1) the ability to apply the scientific method to biological problems; 2) the ability to use quantitative reasoning, particularly graphical representation and interpretation of data; 3) the ability to communicate and collaborate

with other disciplines; 4) the ability to use modeling and simulation; and 5) the ability to understand the relationship between science and society.

Degrees. We offer four undergraduate degrees and several concentrations to facilitate tailoring coursework to align with individual interests and career aspirations.

B.S. in Integrative Biology		
B.S. in Environmental Biology		
B.A. in Zoology		
B.S. in Zoology. Students enroll in one of the concentrations to the right.	Marine Biology	*Cell and Developmental Biology
	Ecology, Evolution, and Organismal Biology (EEOB)	*Genetics
	Zoo and Aquarium Science	*General Zoology
	Animal Behavior and Neurobiology	

*No new students are currently admitted to these programs. IBIO-internal discussions are ongoing about the future of these concentrations.

Our students express appreciation for the diversity of degrees and concentrations from which to choose. Our recently developed BS degree in Integrative Biology offers a broad background at both the organismal and cellular level, preparing students particularly well for entry to medical and veterinary schools. Many students come to MSU specifically because they want a B.S. in Zoology. Concentrations in Zoo and Aquarium Science (our most popular program with over 200 students), Marine Biology, and Animal Behavior are major drawing cards, as are many of our individual courses (e.g., Herpetology (IBIO384), Biology of Mammals (IBIO365), Marine Biology (IBIO353), etc.).

Courses. All of our students complete our core curriculum of Ecology and Ecology Lab (IBIO355, 355L), Genetics (341) and Evolution (445). Additional coursework specific to each degree/concentration is required with the minimum requirement of 33 credits, depending on the specific track.

Service courses. IBIO both participates in service course programs and offers IBIO courses that serve other majors.

Biological Sciences, for science majors	BS 161 Cells and Molecules BS 171 Cells and Molecules laboratory BS 182H Honors Cells and Molecules BS 162 Organisms and Populations BS 172 Organisms and Populations lab
Integrated Studies in Biology, for non-science majors	ISB 202 Applications of Environmental and Organismal Biology ISB 204 Applications of Biomedical Sciences
IBIO course for non-Biology science majors	IBIO 150: IBIO from DNA to Populations
Upper division IBIO service courses	IBIO 341: Fundamental Genetics IBIO 355: Ecology

Study Abroad programs headed by IBIO faculty	Study Away programs headed by IBIO faculty
Conservation Medicine in New Zealand Wild Borneo and Sulawesi: Where Worlds Collide BEAM: Behavioral Ecology of African Mammals Natural Science in New Zealand	Hawaii Environmental Science Orlando Science Behind the Scenes Michigan Careers at the Zoo, Binder Park Zoo Streams to Gulf: Environmental Change in America's Deep South

Online courses offered during summer session:

- IBIO 150: IBIO from DNA to Populations
- IBIO 300: Neurobiology
- IBIO 310: Psychology and Biology of Human Sexuality
- IBIO 313: Animal Behavior
- IBIO 341: Fundamental Genetics
- IBIO 355: Ecology
- IBIO 416: Nervous System Development
- IBIO 445: Evolution
- IBIO 368: Zoo Animal Biology and Conservation

Preparation for careers. Communicating information on careers inside and outside of academia to students is particularly important in IBIO because of the wide variety of career paths associated with our discipline. This information is imparted both in one-on-one advising and in the classroom. Beginning at new student orientation (NSO, previously AOP), our Department continuously encourages students to pursue all possible hands-on opportunities to build skills beyond our already numerous lab courses. We recommend gaining as much experience as possible in areas including independent study, undergraduate research, education abroad, opportunities at Kellogg Biological Station, and internships. We strongly recommend that our students participate in an internship during their college career. In fact, three of our programs have some sort of experiential component as a requirement for graduation.

IBIO sends out biweekly newsletters of announcements and hands-on opportunities to all of our undergraduate students. We maintain an online database of hands-on opportunities and encourage our students to examine these position descriptions early and often. We also have a “career preparation” web page that encourages students to assess and articulate their skills as they move through their degrees and prepare to apply for jobs.

We are developing a 200-level freshman majors’ course for all IBIO students (IBIO 200, Animal Biodiversity FS19). Currently, the diversity of life in general and of animals in particular is not covered in the introductory biology series (BS 161 and 162). This new course will fill the gap by presenting animal biodiversity in the context of evolution, ecology, conservation, and research. As the same time, it aligns well with the MSU Pathways Initiative by providing first-year students with clear ideas of career trajectories in the field of biology and helping students understand how their specific program prepares them for these careers.

DEI

IBIO has formed a DEI committee to address issues of diversity, equity, and inclusion in our Department. Current ideas specific to the undergraduate program include: all teaching faculty taking DEI training; efforts to reach out to high schools and establish pipelines to IBIO for underrepresented students, and then providing mentoring programs for those students once they arrive on campus; evaluation of IBIO classroom environments.

External Factors affecting IBIO Undergraduate Programs

Bottlenecks impedes degree progression. Students must complete the two-semester biological science series (BS 161 Cells and Molecules and BS 162 Organisms and Populations, or alternative Lyman Briggs, Honors, or transfer courses) as prerequisites to begin taking IBIO courses. Each of these courses have their own chemistry and/or

math pre- or co-requisites. Consequently, many students - depending on several factors including their math placement upon matriculation - do not begin their IBIO coursework until their third year. Further, students that come in 'on track' (starting with calculus) often struggle to find appropriate classes to fill their schedules in their first and second years. An added complication is the limitation of spaces in IBIO 341 (Fundamental Genetics), which is a prerequisite for Evolution (IBIO 445). Both of these courses are required for all IBIO students, but IBIO 341 is also a requirement or an option for eight majors and programs and thus fills rapidly every semester. We predict that the struggle to "Go Green, Go Fifteen" with these bottlenecks will only be exacerbated by the advent of Flat-Rate Tuition FS19.

Explicit connections between biology and the general science coursework need strengthening. Students report that they experience difficulty making connections between their math, statistics, and physics courses and their IBIO curriculum.

Human Biology. The potential dissolution of the Human Biology Program has been on the horizon for years. If realized, many current and future students interested in medical careers may choose IBIO majors.

Internal Factors affecting IBIO Undergraduate Programs

Curricular revision is needed. The Department is at a crossroads. We have established, successful undergraduate major programs whose curricula need improved alignment with the strengths of our new faculty cohort. Additionally, faculty attrition has resulted in the loss of some key courses (e.g., Environmental Physiology), leaving holes in our curricula. Our academic advisors report that students express enthusiasm for the opportunities our department provides, but are frustrated when they are unable to schedule courses.

Lack of community. A recent project by IBIO Undergraduate Adviser K. Oeschger, in which she conducted "user experience" interviews with a cross-section of IBIO undergraduate students revealed an emergent theme of a perceived lack of community - both among students and between students and faculty.

Strategic Plan for Teaching

Our goal is to provide students with the space to explore the vast career options in this field, and the resources to build their skill sets towards successfully entering their career path upon graduation. With this in mind, we plan to address each of the external and internal factors listed above (see also Table 4).

Relieving the bottleneck to degree progression. One of the goals of the new IBIO 200, Animal Biodiversity course is to serve as an alternative pre-requisite route to some of our upper division courses, allowing our students earlier access to these courses. Students will have an easier time filling their schedules, and earlier enrollment in majors' courses will lead to better engagement with the Department.

Making explicit connections between biology and the general science coursework. Building on the momentum of the Biology Initiative, we will continue to seek out collaborations across departments, to bring biological examples into courses like CMSE 201 (Intro to Computational Modeling), PHY 241/242 (Physics for Cellular and Molecular Biology I and II), STT224 (Introduction to Probability and Statistics for Ecologists), STT 231 (Statistics for Scientists), and MTH 124 (Survey of Calculus I, for sections that emphasize applications in the life sciences). These connections would allow us to adopt a common language in our IBIO classes so that students are better able to see the connections between their general science courses and their advanced coursework in IBIO. This would allow us to, for example, create a statistical thread through our courses, reinforcing statistical skills and their use in the biological sciences.

Welcoming Human Bio students. IBIO is poised to welcome Human Biology students should the major be discontinued, provided we have the resources. We were mindful of this in the creation of our new IBIO major but have not explored how an influx of Human Bio majors would affect our Department in terms of course enrollment and advising load. This will be part of our 2019-2020 curriculum review.

Curricular revision. We plan a curricular revision during 2019-2020. A committee will map course outcomes to program outcomes, identify gaps and redundancies in course offerings, and work with the Faculty to craft a plan that builds on our current strengths (e.g., the '-ologies', and Ecology, Genetics, and Evolution) while infusing the curriculum with the skills and interests of the new faculty (e.g., genetics/genomics, evo-devo, macrosystems ecology, statistical computation). This will result in a flexible undergraduate curriculum that prepares our students for the front lines of the biological revolution.

In an effort to alleviate the feeling of 'overwhelm' that many students report, we will work to make our curriculum more transparent, so that students see the connections between their courses and their career paths.

Building community, facilitating communication

Among Undergraduates: The Animal Biodiversity course will offer the opportunity for our undergraduates to meet and work together early in their programs, establishing relationships with one another that will shape their IBIO experience. Working with fellow

majors early in their academic careers will allow our students to form cohorts with which to move through their degrees, contributing to a sense of community.

Between undergraduates and faculty: Our newly established Emerging Scholars Program and planned Animal Biodiversity course will introduce students to the skills needed and provide the faculty access required to obtain research positions in our labs. In Animal Biodiversity, undergraduates will learn about IBIO faculty members and their research projects. Through the research exposure in this course and our Emerging Scholars Program, we will increase the number of students in IBIO majors that obtain research experience in IBIO laboratories.

Among faculty, centering on pedagogy: During our planned curricular review, we will survey our instructors to better understand to what extent our courses are implementing scientific thinking. As part of this effort, we will offer links to resources, tutorials, and lunch-and-learn opportunities for instructors who would like to strengthen this facet of their pedagogy.

6. Resources: budget, space, facilities, personnel, leadership

We are striving to improve one of the most valuable resources that we have, our social capital. We are encouraged by the many collaborations among our young faculty. We have invested in a new departmental seminar series to increase networking within the department among faculty and graduate students. We will continue to develop networking, peer-to-peer mentoring, pre-proposal and proposal review, and other strategies for increasing the productivity and impact of our research, teaching, and service.

Budget Stress

IBIO has an annual budget of approximately \$3.6 million. Approximately 70% of that budget supports salaries of tenure track faculty. Adding academic and office staff, fixed term faculty, and graduate teaching assistants' salaries, 94% of the IBIO department's budget covers the support of personnel for as productive and as efficient a department as IBIO. Thus, only a small fraction of this budget is available to support teaching, office, and research supplies, to repair and maintain equipment and infrastructure, for travel (i.e., to conferences and for visitors and prospective students to visit campus), for instructional technology, and for new faculty start-up funds. Costs for maintaining offices and laboratories in aging buildings are higher than in a new building and most IBIO faculty are housed in older buildings (i.e., the Natural Sciences Building and Giltner Hall). Annual cuts for efficiency chip away at these latter budget categories such that the IBIO Department currently has no way to independently invest in new ventures.

A greater overhead return from grants to departments and faculty will increase our performance. Departments and faculty take risks in hiring personnel and building labs and they are responsible for sustaining the core personnel to run them effectively. We are the entrepreneurs without a sufficient safety net to be able to take the big risks. The safe strategy for faculty without the safety net is to take smaller risks over shorter time periods. Departments could be more productive and have greater impact if more faculty, the more productive faculty, had technicians assigned to run their labs and shared labs to free them to invest in research collaborations and higher risk proposals. A financial safety net and smart investments are critical for an enterprise to grow and perform optimally. Overhead return provides incentive for faculty to seek greater overhead for MSU. Thus, greater overhead return to departments can be a win-win for MSU, colleges, departments, and faculty.

Online student tuition was an opportunity for departments to be entrepreneurial and benefit from extra effort put into online courses. Caps on this source of income growth cut into the ability of the IBIO Department to cover all the non-salary expenses with 5% of its budget. We suggest removing caps. Faculty start-up funds should not have an end date because these funds help early career researchers develop their labs and are crucial to ongoing success of new faculty. Start-up funds essentially serve as a safety net when new faculty have early success with extramural funding. Thus, faculty that are successful with grants early on are, in effect, penalized for their success by a start-up funds end date. This limits faculties' ability to use these funds for future ventures when the time and opportunities are best for those investments. New budget categories solve the university-level accounting problems that called for start-up fund end dates. This policy should be revised and changed.

The IBIO Department has an excellent relationship with the CNS Dean's Office which has led to increased productivity in our department. The CNS Dean's Office has helped with a number of major expenses. The department looks forward to a continually productive relationship with the Dean's office and the upper administration.

Major Personnel Needs

Loss of Tenure Track FTEs – The number of tenure track professors in the Department of Zoology/Integrative Biology had decreased by 20% in the last 15 years. The Department would gain greatly by increasing the numbers of Tenure Track faculty as argued for the research productivity of the department in the research section above.

Retirements of Senior Full Professors – A great proportion of the full professors of IBIO will retire within 4 years. The department needs to hire some new faculty at intermediate and even senior levels to help with departmental service and leadership.

Office Staff Levels have decreased by 1.5 FTEs in the last 5 years. Increased efficiency in managing undergraduate files, reassignment of staff responsibilities, and

efficient collaboration among staff have enabled the staff to accomplish their responsibilities despite the loss of 1.5 FTEs.

Building Manger – A building manager could be hired to perform many functions more efficiently than the office staff who are often tasked unexpectedly with these responsibilities. We will continue development of opportunities and arguments for a building manager for the Natural Science and Giltner Hall buildings.

Department Business Manager – Debra Mills will retire on February 1, 2020. We anticipate start recruiting a new business manager in October.

Department Chair – Tom Getty plans to step down from the IBIO chair position in 2 academic years. With the low numbers of tenured associate and full professors in the Department, now is the time for an extramural search for a senior faculty hire to serve as IBIO chair. We will be developing a request for an extramural search for an IBIO chair.

7. Post-doctoral Research Associate Programs

Integrative Biology has a healthy post-doctoral research associate program with 22 post-docs currently working with IBIO faculty. The number of post-docs has increased in the past five years with increased funding of the new junior faculty. According to a survey of faculty, IBIO has had 62 post-docs in the last 10 years.

IBIO has been working to include post-docs in departmental activities and to develop policies that will improve the quality of the MSU program and better serve post-docs. We have official post-doc representation at faculty meetings, at which they share their comments and concerns on departmental issues. Post-docs have many of the same concerns as our graduate students about increased networking within and outside MSU for research collaborations and employment opportunities, exposure to non-academic career routes, and improved quality of life. The department recognizes that it has a shared responsibility with faculty to manage post-doc experiences. Post-doc networking requires extra effort because they do not arrive with a cohort as graduate students, so opportunities for improving post-doc orientation and networking will be developed. IBIO will work with the MSU Postdoctoral Office to help with post-doc needs. As an orienting guide for starting post-docs, an IBIO post-doc handbook will be developed.

8. Outreach and Engagement

Demand for scientific understanding of biological systems and our experience in academics and research calls for our service and outreach to our university, communities, and the world. Service is critical for supporting our academic and professional organizations. Outreach is critical for translating our knowledge and experience and supporting our communities, state, nation, and the world.

Faculty, students, and staff of Integrative Biology will play leading roles in service and outreach. We will support new and existing interdepartmental graduate training programs and projects, especially EEBB and BEACON, but also BMS, Genetics, Neuroscience, ESPP, Cognitive Science, and the MSU Museum. Integrative Biology will play a significant role in biology outreach through our graduate training programs, research in science education and public education efforts. We will contribute to academic governance at all levels within the University and to advancing science at state, national and international levels through active membership and leadership in professional societies, editorial boards, and science advisory boards. Our goal is to increase the number and stature of the committees and organizations that we support.

Table 1. Departmental metrics from the MSU Office of Planning and Budget for academic year 2018-2019.

OPB Unit Metrics	BMB	EES	IBIO	KBS	MMG	PLB	PSL	NEU
TS FTE	34.7	15	19.3	7	27.1	18.7	25.4	4.8
FT FTE	9.5	3.2	4.4	0	9.5	3.9	11.5	4
REAL GRANT\$	9995624	2768433	5132587	1948591	5735027	7512106	5554737	2061961
Adm SCH	10496	3062	11784	469	13182	2675	13000	3431
UG FTE (FALL)	288	75	421		272	48	231	
GRAD FTE (FALL)	45	34	47		54	42	25	26
GF REAL\$	5549350	2356897	3611801	1419830	5233398	3160382	5123679	1809728
GF REAL\$ / Adm SCH	529	770	307	3027	397	1181	394	527
Admin SCH / (TS+FT FTE)	237	168	497	67	360	118	352	390
~Tuition\$ / (TS+FT FTE)	80738	57202	169053	22780	122456	40243	119783	132561
Grant\$ / TS FTE	288058	184562	265937	278370	211625	401717	218690	429575
100000 * Grant\$ / GF REAL\$	180122	117461	142106	137241	109585	237696	108413	113938
Grant\$ + Tuition\$ / TS FTE	262766	226532	394734	225613	358497	217641	375735	620056
100000 * Grant\$ + Tuition\$ / GF Real\$	244430	161633	253036	148472	195225	266474	194679	178397

Table 2. Scholarly Research Index (SRI) from Academic Analytics for the biology departments in the College of Natural Sciences. Academic Analytics data compares the absolute Scholarly Research Indices of MSU units to each other, and as a percentile to their disciplinary peer groups.

	BMB - B	BMB - MB	EES - E	EES - ES	IBIO	MMG - M	MMG - MG	PLB	PSL	EEBB - Ecol	EEBB - Evol
SRI Rank	71	71	51	85	3	65	17	5	52	28	24
	59.3	61.54	55.36	47.5	85.7	49.21	46.67	88.57	47.42	64.47	59.65
SRI Percentile					1						
Articles Weight	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Awards Weight	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Books Weight	0	0	0	0	0	0	0	0	0	0	0
Citations Weight	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Conf Proc Weight	0	0	0	0	0	0	0	0	0	0	0
Grants Weight	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Table 3. Graduate student training in Zoology: 2008---2013. Comparative data (compiled by Jen Lau for the APR of the W.K. Kellogg Biological Station (April 2012) with data for Integrative Biology added by Kyle Miller) from National Research Council, 2010, A Data---Based Assessment of Research--Doctorate Programs in the United States. These are R rankings from the NRC report.

University Graduate Program	Rank	PhDs per year	# of faculty	% grads in faculty or postdoc positions	% female students	% under-rep minority students
MSU: Integrative Biology	--	7.2	23	79.5	54	2
MSU: KBS	--	4.17	14	64	56	4
UC Davis: Ecology	1	26.4	109	61.5	55.2	11.4
Duke: Ecology	2	4.4	25	78.9	42.9	5.9
Harvard: OEB	2	10.4	33	83.3	37.6	11.6
Berkeley: IB	2	18	55	58.7	44.6	12.4
Cornell: EEB	14	7.2	41	81.8	55	6.8
Indiana: EEB	2	7.2	36	76.5	64.4	10.4
UMN: EEB	8	5	52	61.5	53.2	7.1
Illinois: EEB	14	5.2	47	63.2	43.6	3.2
Iowa St.: EEB	29	2	55	87.5	60.6	3.7
Ohio St.: EEOB	34	6.6	34	56.5	45.7	3.2

Table 4. Strategic Plan for Teaching: Issues and Plans. Our goal is to provide students with the space to explore the vast career options in this field, and the resources to build their skill sets towards successfully entering their career path upon graduation. With this in mind, we plan to address each of the external and internal factors articulated below.

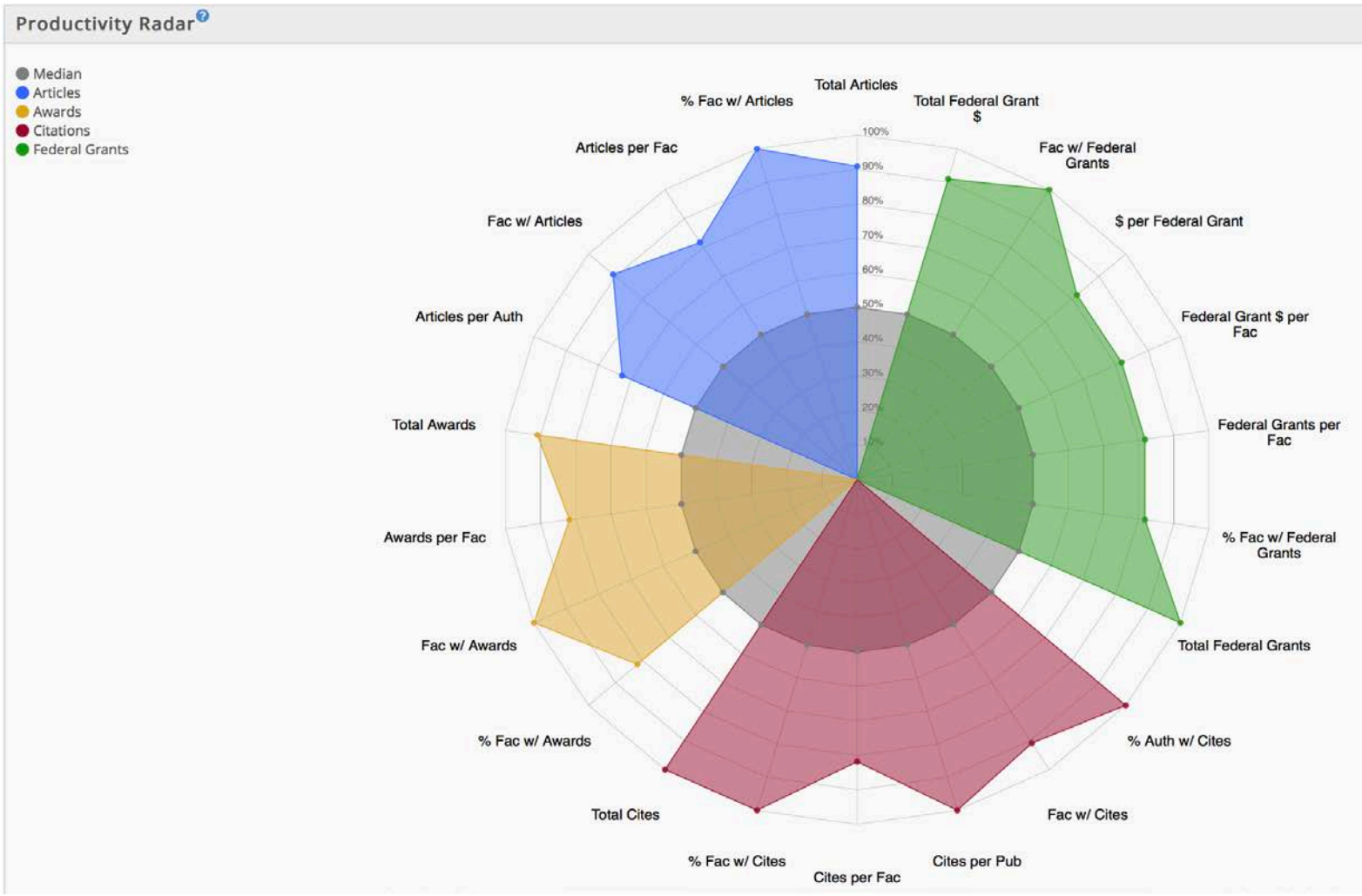
External Factors affecting IBIO Undergraduate Programs	Strategic plan
<p><i>Bottlenecks impede degree progression</i></p> <p>Our strong undergraduate programs require students to complete a minimum of 33 credits in the major. Students must complete the two-semester biological science series (BS 161 Cells and Molecules and BS 162 Organisms and Populations, or alternative Lyman Briggs, Honors, or transfer courses) as prerequisites to begin taking IBIO courses. Each of these courses have their own chemistry and/or math pre- or co-requisites. Consequently, many students- depending on several factors including their math placement upon matriculation- do not begin their IBIO coursework until their third year. Further, students that come in ‘on track’ (starting with calculus) often struggle to find appropriate classes to fill their schedules in their first and second years. An added complication is the limitation of spaces in IBIO 341 (Fundamental Genetics), which is a prerequisite for Evolution (IBIO 445). Both of these courses are required for all IBIO students, but IBIO 341 is also a requirement or an option for eight majors and programs and thus fills rapidly every semester. We predict that the struggle to “Go Green, Go Fifteen” with these bottlenecks will only be exacerbated by the advent of Flat-Rate Tuition FS19.</p>	<p><i>Relieve bottlenecks</i></p> <p>One of the goals of the new IBIO 200 Animal Biodiversity course is to serve as an alternative pre-requisite route to some of our upper division courses, allowing our students earlier access to these courses. Students will have an easier time filling their schedules, and earlier enrollment in majors’ courses will lead to better engagement with the Department.</p>
<p><i>Explicit connections between biology and the general science coursework need strengthening</i></p>	<p><i>Make connections across Departments to facilitate explicit connections between biology and the general science coursework</i></p>

<p>Students report that they experience difficulty making connections between their math, statistics, and physics courses and their IBIO curriculum.</p>	<p>Building on the momentum of the Biology Initiative, we will continue to seek out collaborations across departments, to bring biological examples into courses like CMSE 201 (Intro to Computational Modeling), PHY 241/242 (Physics for Cellular and Molecular Biology I and II), STT224 (Introduction to Probability and Statistics for Ecologists) STT 231 (Statistics for Scientists), and MTH 124 (Survey of Calculus I, for sections that emphasize applications in the life sciences). These connections would allow us to adopt a common language in our IBIO classes so that students are better able to see the connections between their general science courses and their advanced coursework in IBIO. This would allow us to, for example, create a statistical thread through our courses, reinforcing statistical skills and their use in the biological sciences.</p>
<p><i>Dispersion of Human Biology students</i></p>	<p><i>We welcome Human Bio students</i></p>
<p>The potential dissolution of the Human Biology Program has been on the horizon for years. If realized, many current and future students interested in medical careers may choose IBIO majors.</p>	<p>IBIO is poised to absorb Human Biology students should the major be discontinued, provided we have the resources. We were mindful of this in the creation of our new IBIO major but have not explored how an influx of Human Bio majors would affect our Department in terms of course enrollment and advising load. This will be part of our '19-'20 curriculum review.</p>

<p>Internal Factors affecting IBIO Undergraduate Programs</p>	<p>Strategic plan</p>
<p><i>Curricular revision is needed</i></p>	<p><i>Curriculum revision</i></p>
<p>The Department is at a crossroads. We have established, successful undergraduate major programs whose curricula need improved alignment with the strengths of our new</p>	<p>We plan a curricular revision during 2019-2020. A committee will map course outcomes to program outcomes, identify gaps and redundancies in course offerings, and work</p>

<p>faculty cohort. Additionally, faculty attrition has resulted in the loss of some key courses (e.g., Environmental Physiology), leaving holes in our curricula. Our academic advisors report that students express enthusiasm for the opportunities our department provides, but are frustrated when they are unable to schedule courses.</p>	<p>with the Faculty to craft a plan that builds on our current strengths (e.g., the ‘-ologies’, and Ecology, Genetics, and Evolution) while infusing the curriculum with the skills and interests of the new faculty (e.g., genetics/genomics, evo-devo, macrosystems ecology, statistical computation). This will result in a flexible undergraduate curriculum that prepares our students for the front lines of the biological revolution.</p> <p>In an effort to alleviate the feeling of ‘overwhelm’ that many students report, we will work to make our curriculum more transparent, so that students see the connections between their courses and their career paths.</p>
<p><i>Lack of community</i></p>	<p><i>Building community, facilitating communication</i></p>
<p>A recent project by IBIO Undergraduate Adviser K. Oeschger, in which she conducted “user experience” interviews with a cross-section of IBIO undergraduate students revealed an emergent theme of a perceived lack of community - both among students and between students and faculty.</p>	<p><u>Among Undergraduates:</u> The Animal Biodiversity course will offer the opportunity for our undergraduates to meet and work together early in their programs, establishing relationships with one another that will shape their IBIO experience. Working with fellow majors early in their academic careers will allow our students to form cohorts with which to move through their degrees, contributing to a sense of community.</p> <p><u>Between undergraduates and faculty:</u> Our newly established Emerging Scholars Program and planned Animal Biodiversity course will introduce students to the skills needed and provide the faculty access required to obtain research positions in our labs. In Animal Biodiversity, undergraduates will learn about IBIO faculty members and their research projects. Through the research exposure in this course and our Emerging Scholars Program, we will increase the number of students in IBIO majors that obtain research experience in IBIO laboratories.</p>

	<p><u>Among faculty, centering on pedagogy:</u> During our planned curricular review, we will survey our instructors to better understand to what extent our courses are implementing scientific thinking. As part of this effort, we will offer links to resources, tutorials, and lunch-and-learn opportunities for instructors who would like to strengthen this facet of their pedagogy.</p>
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Figure 1. Productivity radar for performance metrics used to calculate the Scholarly Research Index for the Department of Integrative Biology by Academic Analytics.

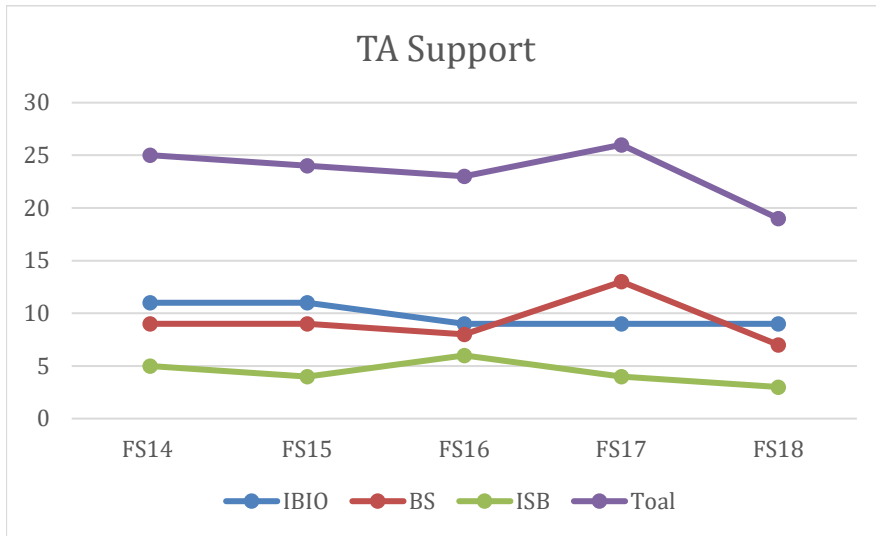


Figure 2. The total number of IBIO teaching assistants supported and the sources of their funding.