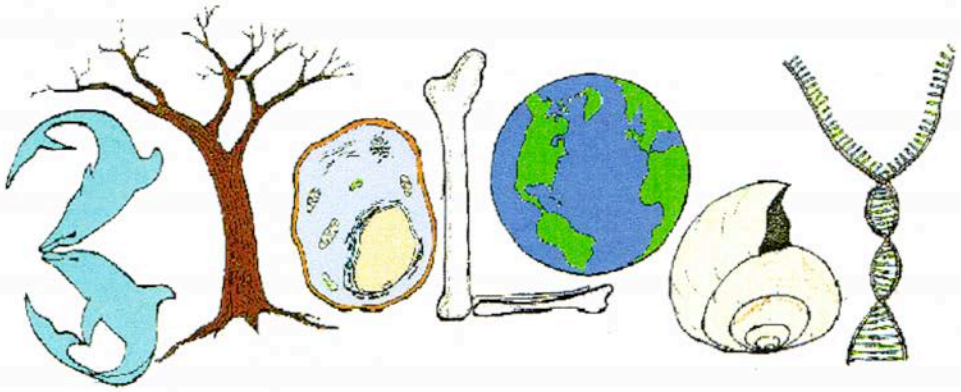

Because Life Is Worth Knowing

# INFORMATION HANDBOOK

## DEPARTMENT OF BIOLOGICAL SCIENCES

## GOUCHER COLLEGE

## 2010-2012

Downloadable from: www.goucher.edu/x4972.xml

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Photos by R.D. Slocum

# BIOLOGICAL SCIENCES AT GOUCHER COLLEGE

The goal of the biological sciences faculty is to promote scientific curiosity, critical thinking, and intellectual maturity in our students through a rigorous curriculum which explores the major disciplines in biology and examines both the diversity of life and the functional aspects of living systems. Biology is not merely a collection of facts but a process of discovery, and students are encouraged to participate actively in this process. Each course provides a framework for examining the scientific process as a means to master current knowledge and to provide a basis to address problems of the future. The core courses encompass the wide spectrum of biology from molecules and cells to populations and ecosystems, using evolutionary adaptation as a recurrent theme. Advanced courses allow students to pursue areas of special interest and stress independence and initiative.

Many biology students participate in research, either in collaboration with a faculty member on campus or at an off campus research setting. This provides an unusual and valuable opportunity for growth in intellectual and scientific maturity beyond the usual undergraduate courses. Results of these studies are occasionally published in scientific research journals. Off campus internships provide valuable practical experience that helps students to make informed career choices. Many students elect internships at community hospitals or at medical or biological research laboratories. Others seek experience at ecological or agricultural research settings that may be as distant as St. Croix or Australia. Upon graduation, many of our students maticulate to top graduate and professional programs, while others pursue a variety of careers in the life sciences and related fields, such as biotechnology, ecosystems research, public health or environmental law.

The Information Handbook should provide prospective students a reasonably complete overview of the curriculum and student and faculty research, as well as post-baccalaureate career and graduate and professional school information. For additional information, please visit the Department of Biological Sciences website (www.goucher.edu/x524.xml) or contact the Chair:

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Hoffberger Science Center

## FACULTY AND STAFF

Contact and biographical information for Biology faculty and staff is available at: www.goucher.edu/x659.xml

*PROFESSORS*

George Delahunty
B.S. Duquesne University, Ph.D. Marquette University
(Animal Physiology/Molecular Endocrinology)

Mark A. Hiller
A.B. Princeton University, Ph.D. Carnegie Mellon University
(Genetics/Developmental Biology)

Cynthia Kicklighter
B.S. University of Miami, Ph.D. Georgia Tech University
(Ecology, Marine Biology)

Birthe V. Kjellerup
M.S. and Ph.D. Aalborg University
(Environmental Engineering/Microbiology)

Judith R. Levin
A.B. Harvard University, Ph.D. University of California, Berkeley
(Biochemistry/Molecular Biology)

Harry Ratrie III
B.A. Virginia Military Institute, Ph.D. University of Tennessee
(Cell Biology/Immunology)

Janet C. Shambaugh
B.S. Northwestern University, Ph.D. Emory University
(Developmental and Cell Biology/Biochemistry)

Robert D. Slocum
B.A. University of Maine, M.S. Ohio State University, Ph.D. University of Texas, Austin
(Plant Physiology/Biochemistry/Molecular Biology)

## FACULTY AND STAFF (cont.)

### *SENIOR LABORATORY INSTRUCTORS*

**Jacqueline Mooney Andrews**
B. A. University of Maryland, Baltimore County; M.S. University of Maryland School of Medicine

**Theresa A. Hodge**
B.S. Mount Saint Mary's College; M.S. University of Maryland

### *LECTURER*

**William B. Hilgartner**
B.S. Towson State University; M.S., Ph.D. The Johns Hopkins University

### *Emeritus*

**Leleng To Isaacs**
B.S. University of Santo Tomas, M.S., Ph.D. Boston University
(Microbiology/Molecular Biology/Cell Biology/Immunology)

**William S. Johnson**
B.S. University of Arizona, Ph.D. Stanford University
(Ecology/Marine Biology)

# PROGRAMS OF STUDY

Detailed descriptions for departmental course offerings can be found at the *Course Descriptions* link on the Department of Biological Sciences web site (www.goucher.edu/x654.xml). Syllabi for all departmental courses can be downloaded from the top of this page. Information about courses and program requirements for other departments can be found in the Goucher College *Academic Catalog* (www.goucher.edu/x1388.xml) or in the *Majors, Minors and Programs* link (www.goucher.edu/x1376.xml).

## THE BIOLOGICAL SCIENCES MAJOR

The major consists of at least 40 biology credits that include a core sequence: BIO 104, BIO 105, BIO 210, BIO 214, BIO 220, BIO 224, BIO 240, BIO 260 or 333/334. BIO 111, BIO 140, BIO 150, 170 and 290 do not count toward the 40-credit requirement. Only 2 credits of directed research (BIO 291) may be counted toward the 40-credit total.

In addition, a minimum of 14 credits at the 300-level, including one seminar and at least one three-hour laboratory course are required. The 300-level courses must represent at least two different biological disciplines. Only one seminar can count toward the 300-level course requirement. The laboratory courses that fulfill this requirement are: BIO 324L, BIO 328, BIO 334, BIO 341, BIO 354L, BIO 363, BIO 378L, BIO 390-399. If both CHE 341 and CHE 345 are elected, 3 credits may be counted toward the 14 300-level credits required for the biological science major.

Students planning to major in biological sciences should elect BIO 104 and 105 and CHE 111/112 (or 112H) and 151/152 (or 152H) in their first year and BIO 210/214 and 220/224 in their sophomore year. CHE 235 and MA 117 are required and should be completed as soon as possible, preferably by the end of the sophomore year. MA 118 is strongly recommended. The major core requirements are normally completed in the junior year by taking BIO 240 and either plant or animal physiology. The last three semesters may be devoted to specialization at the 300-level and independent research. All students, especially those contemplating graduate school, are urged to take both BIO 260 and BIO 333/334. All 200- and 300-level courses in biological science must receive a grade of at least a C- to count towards the major courses. Laboratory reports and papers in BIO 214, BIO 224, BIO 240 and BIO 260 are used to evaluate writing proficiency in the major (see below). Computer proficiency is satisfied by completing the requirements for the major.

### *Concentration in Molecular Biology*

In addition to the core sequence of courses listed above, requirements for a biological sciences major with a concentration in molecular biology are: Two lecture courses, selected from among BIO 324, BIO 327 and BIO 354, two laboratory courses, selected from among BIO 324L, BIO 328 and BIO 354L, one 300-level biology seminar, CHE 235, CHE 341 or 345, MA 117, and two semesters of physics

(PHY 115/116 or 125/126). If both CHE 341 and CHE 345 are elected, 3 credits may be counted toward the 14 300-level credits required for the biological science major.

Molecular Biology Techniques (Bio 224) class

## *Concentration in Environmental Science*

In addition to the core sequence of courses listed above (with the exception that both BIO 260 and either BIO 333/334 or 354 must be completed), the requirements for a biological sciences major with a concentration in environmental science are: BIO 241, BIO 343/343L, BIO 384 or BIO 387, CHE 235, EC 101 or EC 102 (or an environmental economics course), MA 117, and PSC 285.

## *Concentration in Dance Science*

This concentration focuses on knowledge and technique in the new field of dance science. Study of the sciences is combined with technical and theoretical dance training to provide a basis for understanding problems in dance performance, nutrition, and care and prevention of injuries. With additional course work, this concentration provides preparation for graduate studies in physical therapy, sports medicine, dance medicine, and related fields. (See the Director of Premedical Studies for specific requirements.) In addition to the core sequence of courses listed above, requirements for a biological sciences major with a concentration in dance science are: DAN 127/116 or 126/117, DAN 252, DAN 360, PHY 115, an internship or research in dance science.

### *Concentration in Secondary Education with Certification in Biological Sciences*

Students planning to teach biology in secondary schools must major in Biology and complete the required education courses. See teaching certification requirements under Secondary Education Certification in the Education Department (www.goucher.edu/x4321.xml).

## THE BIOLOGICAL SCIENCES MINOR

The minor in biological sciences exposes students to a core of knowledge over the breadth of subdisciplines from molecular biology through ecology. In addition to the core sequence, requirements for the biological sciences minor are: one 300-level BIO course, CHE 111/112, CHE 151/152, CHE 230.

## BIOMEDICAL ENGINEERING GOUCHER COLLEGE -THE JOHNS HOPKINS UNIVERSITY DUAL-DEGREE PROGRAM

Goucher College has established a dual-degree program through which students earn both a bachelor-of-arts degree from Goucher and a bachelor of science degree from the G.W.C. Whiting School of Engineering of The Johns Hopkins University. The purpose of the dual-degree program is to enable students to explore the liberal arts and sciences, while developing professional knowledge and experience in a specific field of biomedical engineering. For additional information or visit the program web site (http://www.goucher.edu/x6377.xml)).

## PRE-MEDICAL, PRE-VETERINARY, AND PRE-DENTAL STUDIES

The course work needed to apply to medical, dental, and veterinary schools includes one year of biology, one year of general chemistry, one year of organic chemistry, one year of physics, and one or two semesters of calculus (varies). This is the minimal course work needed to apply to medical school and competitive applicants usually have more science courses. Thus, most students interested in applying to medical school will major in either biology or chemistry, as the overlap between the premed requirements and the science major requirements is substantial. Majors planning to apply to medical, dental, or veterinary schools should consult George Delahunty, Director of Premedical Studies, for assistance in program planning. For additional information, visit the Premedical Studies web site (http://www.goucher.edu/x6278.xml).

## Writing Proficiency Requirement For The Biological Sciences Major

In addition to the college-wide writing proficiency requirement, writing proficiency within the discipline must also be demonstrated. This requirement is met by satisfactory writing in BIO 224, BIO 240 and BIO 260, which are normally completed by the junior year. Those students who are identified as requiring additional refinement of their writing skills will be required to take either Intermediate Writing (ENG 201) or Scientific and Technical Writing (ENG 206), as is deemed appropriate by the department.


Students investigating the effects of hormones on plant growth and development in Spring 2010 Plant Physiology Lab (Bio 334)

## HONORS IN BIOLOGICAL SCIENCES

Majors in Biological Sciences are encouraged to strive for Honors in the major at graduation. Departmental Honors will be awarded on the basis of outstanding performance in both 1) course work in the Biological Sciences at the 200 and 300 levels and 2) an independent laboratory or field research project which conforms to the guidelines for independent research projects. The results of this research must be presented at an open seminar attended by students and faculty near the end of spring term.

If you wish to be considered for honors in the major you should plan your schedule to include independent research. Independent research requires more than one semester, so plan to begin by the fall of the senior year.

### Requirements for Honors in Biology

Students recommended for departmental honors are selected from those who meet the following criteria:

1. A *minimum* overall grade point average of 3.00. Excluded from the GPA calculation are summer school courses taken away from Goucher.

2. A *minimum* grade point average of 3.00 for all courses taken in the Department of Biological Sciences exclusive of 100 level courses. (In the case of transfer students, courses counting toward the major which were taken at the previous home institution in the regular academic year are included).

3. A high level of achievement in 2 semester (or summer plus 1 semester) independent research project, the results of which are presented at an open seminar attended by students and faculty.

Final selection requires approval by a majority of the faculty members in the Biological Sciences Department.

Independent research student Catherine Czaya ('02) conducting molecular biology experiments in Professor Delahunty's laboratory

# OFF-CAMPUS EXPERIENCE

*Internships*

Because career development is an integral part of the total college experience, students earn credits while acquiring applied skills through off-campus internships or research. The internship program offers an exceptional opportunity to combine practical experience with your education. Working in an area of interest often provides the critical insight needed to make career decisions. In addition, the contacts made off campus often lead to job offers or to valuable recommendations.

Internship positions are normally obtained through the Career Development Office, but students may also consult faculty, friends, relatives, students, or other contacts. Thus, looking for an internship is a little like looking for a job. Once an off-campus sponsor is located, arrangements for receiving credit are made with a faculty sponsor in the department, and an *Internship Learning Agreement* is completed (forms and guidelines for internships can be obtained from the Career Development Office; www.goucher.edu/x12089.xml). Usually, a brief report or journal of a student's activities is required along with a letter from the sponsor. In recent years, most students have elected to present their research experiences at the science student poster session early in the fall semester. All internships in biology (BIO 290) are graded on a Pass/No Pass basis.

The following list indicates the variety of locations in the Baltimore area where internships have been completed in recent years:

Baltimore Zoo
U.S. Dept. of Agriculture, Beltsville, MD
National Institutes of Health, Bethesda, MD
Clyburn Arboretum, Baltimore, MD
U.S. Food and Drug Administration, Rockville, MD
Lyn Animal Hospital, Riverdale, MD
Johns Hopkins University, Baltimore, MD
Kennedy Institute, Baltimore, MD
Maryland Science Center, Baltimore, MD
National Aquarium in Baltimore, MD
Scios/Nova Pharmaceuticals, Baltimore, MD
Reinforced Earth Co., Arlington, VA
VERSAR Environmental Consultants, Columbia, MD
Patuxent National Wildlife Research Center, Patuxent, MD

Premedical Internships have been done at a variety of hospitals including: Children's Hospital, Philadelphia; Southwest Community Hospital, Atlanta, GA; Johns Hopkins Medical Institutions; Francis Scott Key Medical Center, Baltimore; Children's Hospital, Phoenix, AZ; Sinai Hospital, Baltimore; University of Maryland Hospital, Baltimore; Loch Raven Veterans Administration Hospital, Baltimore; Jervis St. Hospital, Dublin, Ireland; Sacre-Coeur Hospital, Beirut, Lebanon.

## AWARDS AND PRIZES FOR EXCELLENCE

A number of awards are given annually to students in the Biological Sciences for outstanding work in specific disciplines. The following list indicates the criteria used by departmental faculty in selecting winners of each award:

*Jessie L. King Prize*

Awarded to a senior who has done outstanding work in any field of science included in Division III (Natural Sciences and Mathematics) with special consideration given to the study of Mammalian Physiology and/or Microbiology.

*Gairdner B. Moment Award*

Presented to a senior who has demonstrated superior achievement in the Biological Sciences, especially in the field of Animal Development.

*Leah Seidman Schaffer Prize*

Awarded to a senior who has conducted outstanding independent study in Microbiology.

*Ann Matthews Lacy Prize*

Given for meritorious achievement in class work, laboratory work or special projects in genetics, to students judged to have outstanding potential for further achievement in the field of genetics.

2003 Phi Beta Kappa induction ceremony for Biology majors (L->R: Amy Hauser, Andrea Drzewianowski, Shelley Lloyd, Jocelyn Reader, Jennifer McCulley)

# CAREERS IN BIOLOGY

## Information and Guidance

Applications for jobs, graduate, and professional schools should be obtained early in the senior year. Notices of special opportunities are posted on bulletin boards in the Science Building. The Biology Department regularly sponsors speakers who can provide information on specific career opportunities of interest to majors. For additional guidance and specific information, students should consult their major advisor or any member of the Department. Information and advice is also available in the Career Development Office (www.goucher.edu/x2996.xml), an often-overlooked resource that provides valuable support at all stages of career planning.

### Cover Letters

Cover letters sent with applications should not be taken lightly. This sheet explains why you are applying and is often the first impression reviewers of your application have of you. Do not rely on your resume and transcript alone. In fact, these may not even be read in much detail. The cover letter is an excellent place to provide the personal information that distinguishes you from other applicants. Try to create a connection between your experience and expertise (e.g., your interests and excitement about specific areas of biology), and the particular job or graduate program to which you are applying. Here you may be able to highlight aspects of your research or internship experience that could become buried in your application materials.

In addition to the content, the reader of your application will read between the lines. A well-crafted essay tells a lot about your scientific maturity, your ability to express yourself in writing, and how serious you are about the position. Take advantage of this opportunity. Your advisor or other faculty members will provide feedback if requested.

### Resumé

Unlike resumes for business, your resume is ***not*** limited to a single page. Just make sure that it is not padded with irrelevant information. Include and emphasize those things that will be most relevant to the specific job or program, and delete extraneous material. For example, you may want to include a list of specific skills and expertise that you have gained through courses, internships, or research. Your experience with gel electrophoresis, southern blots, radioisotopes, statistics, field techniques, or toxicity bioassays may be exactly what someone needs. Your proficiency here is not likely to be obvious from a course list. The Biology faculty are happy to provide guidance in the development of your resume.

### Letters of Recommendation

Biological Sciences faculty are genuinely concerned about your future and are dedicated to assisting you in attaining whatever goals are consistent with your

interests and abilities. Do not hesitate to ask for letters of recommendation. A general recommendation letter kept on file is not effective. Even if you should need a recommendation some years after graduation, your best bet is to contact faculty members directly.

If recommendations are to be effective, they must be custom tailored to you and the position you seek. Vague generalities make poor recommendations - even if written in glowing terms. Individual letters to graduate schools and employers are better than file letters written for a wide range of circumstances. The more information we have, the more specific and personal we can be. When you request a letter of recommendation, please supply the following information:

1. A list of your science and math courses (with grades).

2. Other experience. Please be specific about jobs or volunteer work, independent projects, and any other related experiences which could be valuable.

3. A description of the exact position or course of study for which you are applying and why you want it.

4. Deadline for the application.

Professor Hank Ratrie discusses independent research projects with Bio 105 students

## Career Choices of Recent Graduates

Biology graduates have adapted to a variety of niches once leaving Goucher. Listed below are some of the choices of recent graduates:

Graduate study in

Public Health programs at Yale, University of North Carolina, University of Pittsburgh and Johns Hopkins University

Hospital Administration at Temple University and Loyola College

Biological Sciences at Harvard, Emory, Case Western, University of South Carolina, VPI , Cornell, and University of California, Irvine.

Biochemistry, University of North Carolina, Chapel Hill.

Law School, with specialization in Environmental Law and Patent Law.

Biocomputing and data analysis at environmental and medical research centers.

Medical, dental and veterinary schools

Research technician positions in laboratories throughout the Baltimore/Washington area including Carnegie Institute, Johns Hopkins Medical School, University of Maryland Medical School.

Jobs in private industry: Quality Control Tech at Sigma Chemical Co., Nova Pharmaceutical, Research Assistant at VERSAR Environmental Consultants. Research Assistants and Statisticians at Ecological Analysts, Coral Reef Exhibit Head at Smithsonian Institution, St. Louis. Research Technician McCormick Spice Company, Bethesda Research Laboratories, Rockville, MD.

Moment wing, Hoffberger Science Building

## APPLICATION TO GRADUATE PROGRAMS

Those considering graduate school should discuss their plans and interests with the faculty member(s) in appropriate area(s) of biology. Internships and independent research may provide particularly useful preparation and improve chances of acceptance.

### Where to Apply?

Your faculty advisor may have inside knowledge about particular programs and may help you narrow the choice. However, you should write for information and application forms by early September of your senior year, if not earlier. A wealth of information about graduate programs can now be found on the Internet.

### Application Process

Most graduate program provide online application forms, but some still require paper applications. Filling out application forms carefully and neatly is both tedious and crucial. Essay questions about your plans and interests are particularly important. Often different essays are needed for different schools, so don't attempt a "one essay fits all" approach. The extra time spent can really make a difference. You might ask your advisor to assist you to insure that the proper thrust and tone are presented.

This is also the time to request letters of recommendation from professors and from others who know you well from a scientific setting (internship, directed or independent research). Please see the guidelines for requesting Letters of Recommendation located earlier in this section to help us write better letters for you.

### Graduate Record Examination (GRE)

You should plan to take the GRE even if you are unsure about immediate entry into graduate school. Most people take these tests twice during their senior year because scores usually improve the second time. GRE scores can be critical, depending on the school. Some preparation for them is really useful. Reading a good introductory Biology text is an excellent way to begin. Check with the Career Development Office for test dates, application forms, and practice tests.

## APPLICATION TO MEDICAL, VETERINARY, AND DENTAL SCHOOLS

The Premedical Studies Committee helps students to become competitive applicants, guides them through the application process, and writes a personalized letter of recommendation for each applicant.

In addition to advising, the Committee provides a variety of support services. These include practice MCAT tests and MCAT review service, essay writing workshops for applications, and a premedical internship during the junior year for qualified students. The Committee also brings in several speakers each year to talk about various aspects of medicine and other health related fields.

Students interested in medical and related professional schools should contact the Chair of the Premedical Studies Committee, Dr. George Delahunty, for further information, or visit the *Premedical Studies* web site (www.goucher.edu/x6278.xml)

## FELLOWSHIPS FOR GRADUATE STUDY

Selections for the following fellowships are made by the college Lectures and Fellowships Committee. Application information can be obtained from the Associate Dean's office.

### *Stimson-Duvall Fellowship*

Awarded to students demonstrating professional promise and outstanding qualifications for graduate studies in the natural, physical, biological and medical sciences or the related field of history of science.

### *Dean Van Meter Alumni Fellowships*

Awarded for graduate or professional studies in the U.S. or abroad.

### *Flora E. Langdon Fellowship*

Awarded to women of exceptional ability who pursue graduate studies in Botany at a U.S. university recognized for its facilities for graduate work in the plant sciences.

## STUDENT RESEARCH OPPORTUNITIES

Faculty commitment to meaningful research experiences for our students is a hallmark of the sciences at Goucher. The modern laboratory facilities in the Hoffberger Science Building permit many different types of faculty-student research collaborations. (for additional information on facilities and equipment, visit the *Facilities* link on the Department of Biological Sciences web site (http://www.goucher.edu/x525.xml) Approximately one third of our majors elect to participate in directed research or independent research experiences, either with departmental faculty or research mentors at other institutions. The large number of research universities, medical schools and biotechnology companies in the Baltimore area provide nearly unlimited opportunities for our students to gain research experience in virtually any discipline within the life sciences and related fields.

The biology faculty are actively-engaged in research and many have extramural support from the National Science Foundation (NSF), the National Institutes of Health (NIH), and other federal agencies and private foundations. The college also provides significant support for faculty-student research. Students present their research at national and international meetings and co-author a third of peer-reviewed faculty publications. About 40% of biology majors enter graduate programs and, over the past 15 years, 14.5% have earned Ph.D. degrees within 6 years of graduation, ranking this program in the top 20% among liberal arts colleges in the U.S.

## DIRECTED RESEARCH

Students who are unsure whether they want to pursue an independent research experience may elect to take a Directed Research (BIO 291) course. The course may be repeated once with the same, or a different, faculty member, but only 2 credits of directed research may be counted toward the 40-credit total for the Biology major. Sophomore standing, or permission of the department is required to take BIO 291.

The student conducts laboratory or field research under the direction of a departmental faculty member. As for independent research projects, the student initially writes a brief research plan, outlining major goals of the research project. Upon completion of the research, a written report, in the form of a journal article, is submitted to the faculty sponsor.

Students who wish to be considered for Honors within the Biology major must complete an appropriate senior independent research course (BIO 390Y-399Y). Directed research does not meet these requirements (see below).

# INDEPENDENT RESEARCH

Independent research provides a special opportunity for advanced students to pursue a research topic in their area of interest. Students considering graduate studies are especially encouraged to explore this possibility with a departmental faculty sponsor.

The student designs a 2 semester (or, occasionally, summer plus 1 semester) laboratory or field research project, under the guidance of a faculty sponsor, whose experience is helpful in establishing what can reasonably be accomplished given available resources and the limited duration of the project. Experimental work should begin no later than fall semester of the senior year and, preferably, in the summer preceding the senior year. The research may take place on campus or at an off-campus location.

## The Proposal

A research proposal should be submitted to each member of the Biological Sciences faculty for approval no later than the end of the second week of the semester in which research will begin. The proposal should include the following:

1. Statement of Purpose. A clear statement of purpose, describing the aims of the proposed research and their relevance to the current state of knowledge in the area of investigation. The project is designed after a thorough literature survey and references to key papers in the field should be cited a bibliography.

2. Experimental Plan. The design of the project is conducted in collaboration with the faculty research sponsor but should, to the extent that it is possible, be shaped independently by the student. An outline of methods and experimental approaches to be used, and expected results, are provided. Details of data acquisition and analysis techniques are included.

3. List of Required Supplies and Equipment. A list of supplies and equipment required to support the proposed research project, and their estimated cost and availability, are provided.

4. Projected Research Schedule. Projected time required to complete each phase of the research, including data analyses, etc. is indicated.

## Final Report

The Final Report is a paper, written in the format of an article to be submitted to a peer-reviewed journal within a given discipline. Statistical treatment of data is expected, when appropriate. Copies of the paper are provided to the research advisor and other members of the department. Research of outstanding quality may be submitted for publication.

### Oral Presentation

All student investigators are expected to share their research findings in a formal seminar presented to science faculty and students. The seminar is scheduled near the end of the spring semester and precedes BioBlast, the annual departmental picnic. The oral presentation is required for Honors in Biology.

## OFF-CAMPUS INDEPENDENT RESEARCH

Occasionally, students demonstrate sufficient competence and maturity to pursue a program of scientific investigation in an off-campus research setting. Off-campus independent research is equivalent to Goucher-based independent study and earns 300-level biology credit. Off-campus independent research requires both careful planning and approval by all three parties involved (student researcher, Biological Sciences Department and the off-campus sponsor). It is best to make appropriate arrangements well in advance. This research may also fulfill the off-campus experience requirement (BIO 290 internship). For further information about internship requirements, visit the *Internships* link at Career Development Office web site (www.goucher.edu/x12089.xml).

### Courses at Marine Biology Laboratories or Biological Field Stations

Most universities and some independent laboratories have programs during January term, or during the summer months, that emphasize studies of living organisms in their natural environments. Students who wish to meet the requirement for an off-campus experience through a scheduled program at a marine biology laboratory or a biological field station must obtain approval of the department. The Mary Derrickson McCurdy Fellowship provides support for marine biology research at field stations (see below).

Becky Ball ('02) checking field mouse traps in the Goucher woods

## FELLOWSHIPS AND GRANTS IN SUPPORT OF RESEARCH

Students interested in conducting research during the summer may apply for research stipends (currently $3,500). These stipends cover 10 weeks of research and campus housing fees.

### *Merry Derrickson McCurdy Fellowship*

Supports research or course work at a marine field station. Applications for January term, a semester, or summers at field stations are made to the department. Selection is based on academic record and relevance of marine study to career goals. Preference to juniors or seniors.

### *Katharine Welsh Research Fellowship*

Supports research in the natural sciences carried out with a Goucher Faculty member or with an off-campus mentor (usually a Goucher alum). Open to students in the biological and physical sciences, with preference given to biology majors (Katharine Welsh '30 was a biology major).

### *Faculty Research Grants*

Individual faculty members often have grants from government or private agencies or foundations that provide funds for one or more research students each year.

### *Institutional Research Grants*

Faculty in the Natural Sciences have been successful in securing a variety of research grants which provide student summer research stipends, travel to scientific meetings, and funds for equipment and supplies in support of research. Recently, we have received grants from the Howard Hughes Medical Institute, the Merck/AAAS Undergraduate Science Research Program, and Research at Undergraduate Institutions (RUI) awards from the National Science Foundation.

# FACULTY RESEARCH INTERESTS

## GEORGE DELAHUNTY

*Research Interests:* Evolution of Insulin Function and Glucose Homeostasis, Molecular Biology of Insulin-Like Growth Factors, Serotonergic Control of Cardiovascular Function

*Research in Progress:*

Current research examines the role of insulin and glucose homeostasis in the amphibian, *Xenopus laevis.* The animal model provides a special system to examine the evolution of insulin function in vertebrates, as amphibians produce most of their energy via glycolysis and the genome for *Xenopus* has been sequenced. Thus, allowing for studies at both the physiological and molecular level. Recent studies include both glucose and insulin tolerance curves and labeled glucose incorporation into *Xenopus* adipocytes, *in vitro.*

The growth factor project attempts to understand the molecular endocrinology of growth by studying the evolution and tissue specific expression of the insulin-like growth factor I (IGF-I). Currently, research projects are focused on the tissue specific expression and growth hormone control of the IGF-I genes in *Xenopus laevis and Xenopus tropicalis*, amphibian models commonly employed to study development. Recombinant DNA techniques are used to isolate and characterize the messenger RNA, which codes for the IGF-I hormone in *Xenopus.* The expression of the IGF-I gene during development, and the hormonal control of IGF-I expression in adult animals are also examined.

The last project studies the effect of serotonin on cardiovascular function using the bullfrog as a model system. Students have utilized both *in vivo* and *in vitro* preparations to examine the effect of serotonin on cardiac function and blood pressure regulation. Currently studies are being carried out to characterize the serotonergic receptor subtype(s) involved in the cardiovascular response.

GEORGE DELAHUNTY (cont.)

*Representative Student Independent Research Projects:*

| | |
|---|---|
| Sleeper, Aimee | Effects of serotonin on the heart rate of *Rana catesabiana.* |
| Hoffeld, Erika | Tissue-specific expression and growth hormone regulation of IGF-I' and IGF-I" in adult *Xenopus laevis* liver. |
| Czaya, Catherine | Growth Hormone regulation of tissue specific expression of IGF-I transcripts in *Xenopus laevis*. |
| Webster, Rachel | Characterization of the 3' splicing variants of IGF-I mRNA from *Xenopus tropicalis* liver. |
| Brittany Foster | Insulin Function and Glucose Homeostasis in *Xenopus laevis.* |

# MARK A. HILLER

*Research Interests:* *Drosophila* genetics and developmental biology, regulation of gene expression, and reproductive biology.

*Research In Progress:*

Regulation of Gene Expression

Gene expression is a tightly regulated process that directs both cell fate decisions and development. Every gene in the genome of a multi-cellular organism must be expressed in the correct cell type and at the correct time during development. However, the mechanisms that regulate this process are largely unknown. To study tissue-specific transcription we are studying spermatogenesis in the fruit fly *Drosophila melanogaster*. The complex cellular changes that produce fully differentiated sperm depend on a robust transcriptional program in developing germline cells. Using a wide range of genetic and molecular biological techniques, we are investigating several male-sterile mutants that do not correctly regulate gene expression of spermatid differentiation genes. Analysis of the male sterile mutants indicates that function of several tissue-specific subunits of the general RNA polymerase II machinery are important for transcription in the fly germline. Interestingly, mammals also have tissue-specific general transcription machinery, and thus the general mechanisms regulating gene expression in *Drosophila* may be conserved in mammals.

*Representative Publications:*

Hiller, M.A., T.-Y. Lin, C. Wood, and M.T. Fuller (2001) Developmental regulation of transcription by a tissue specific $TAF_{II}$ homolog. *Genes and Development* 15: 1021-1030.

J.J.Hwa, M.A. Hiller, M.T. Fuller, A. Santel (2002) Differential expression of the *Drosophila* mitofusin genes *fuzzy onions* and dMfn. *Mechanisms of Development* 116: 213-216.

Perezgasga, L., J-Q. Jian, B. Bolival Jr., M. Hiller, E. Benson, M.T. Fuller, H. White-Coper (2004) Regulation of transcription of meiotic cell cycle and terminal differentiation genes by the testis-specific Zn-finger protein matotopetli. *Development* 131: 1691-1702.

Hiller, M.A., X. Chen, M.J. Pringle, M. Suchorolski, Y. Sancak, S. Viswanathan, B. Bolival, T-Y. Lin, S. Marino, and M.T. Fuller (2004) Testis-specific TAF homologs collaborate to control a tissue-specific transcription program. *Development*. 131: 5297-308.

Chen X, Hiller M, Sancak Y, Fuller MT. (2005) Tissue-specific TAFs counteract Polycomb to turn on terminal differentiation. *Science* 310: 869-72.

# CYNTHIA E. KICKLIGHTER

*Research Interests*: Marine ecology, chemical ecology, predator-prey interactions, and marine invertebrates.

*Research in Progress*:

Anti-predation strategies of marine organisms

Predation is a major force affecting the distribution and abundance of organisms and influencing population and community properties. How communities are organized and maintained is fundamental to understanding ecosystem function. Thus, investigating the behavior and ecology of organisms in terms of how they deter or avoid predation yields insight into selective pressures that have shaped populations and species, as well as the major processes affecting community structure and composition.

My research involves a combination of field and laboratory studies, primarily focusing on two areas: 1) how marine polychaete worms integrate behavioral escape and chemical defense strategies to lessen their susceptibility to predation and 2) the use of chemical defenses to deter snail feeding in salt marsh grasses in the Chesapeake Bay.

*Selected Publications*:

Kicklighter CE, Barsby T, Kubanek J and Hay ME (2003) Palatability and defense of some tropical infaunal worms: alkylpyrrole sulfamates as deterrents to fish feeding. *Marine Ecol. Progress Ser.* 263: 299-306.

Kicklighter CE, Shabani S, Johnson PM and Derby CD (2005) Sea hares use novel antipredatory chemical defenses. *Curr. Biol.* 15: 549-554.

Kicklighter CE and Hay ME (2006) Integrating prey defensive traits: a contrast of marine worms from temperate and tropical habitats. *Ecol. Monographs* 76: 195-215.

Kicklighter CE and Derby CD (2006) Multiple components in the ink of the sea hare *Aplysia californica* are aversive to the anemone *Anthopleura sola*. *J. Exp. Marine Biol. Ecol.* 334: 256-268.

Kicklighter CE and Hay ME (2007) To avoid or deter: Interactions among defensive and escape strategies in sabellid worms. *Oecologia* 151: 161-173.

Kicklighter CE, Germann M, Kamio, M, and Derby CD (2007) Molecular identification of the alarm cues in the defensive secretions of the sea hare *Aplysia californica*. *Animal Behaviour* 74: 1481-1492.

## BIRTHE VENO KJELLERUP

*Research Interests:*

Determination of bacterial and archaeal identity, diversity and activity in complex microbial systems such as biofilms in wastewater, soil/sediments and the human body; Aerobic and anaerobic degradation of persistent organic pollutants, mainly polychlorinated biphenyls (PCBs); Biocorrosion (for instance oil distribution pipelines and heating systems).

*Research In Progress:*

My research focuses on biofilms found in humans, the environment or in industrial settings. A biofilm consists of microbes attached to a surface and embedded in slime. This way of living gives microbes in biofilms important advantages compared to their free-floating counterparts. These advantages include increased nutrient availability and increased resistance towards sudden changes in environmental conditions such as increased shear forces, pH changes, dehydration or grazing from other organisms. In addition, the biofilm also functions as a mechanical barrier that limits the diffusion of toxic substances, thereby protecting and creating microenvironments that selects for diverse microbial populations.

Biofilm approaches are applied in my research to investigate the degradation of toxic compounds in soil and sediment such as PCBs (Polychlorinated Biphenyls). PCBs are widespread in the environment and can be found globally as a result of transport in oceans and the atmosphere. In the environment, PCBs adsorb to particles that accumulate as a result of sediment deposition and they can enter the food chain. Here they accumulate in lipids and can cause dermal toxicity, immunotoxicity, carcinogenesis, endocrine and reproduction effects in both humans and animals. Bioremediation benefiting from the presence of native bacteria growing in biofilms is currently being researched in my laboratory as well as the effect of alternating aerobic and anaerobic conditions in biofilms contaminated with PCBs. In addition, we investigate the diversity of bacteria in biofilm samples from the human body including sputum from cystic fibrosis patients, foot wounds from diabetic patients and dental samples from patients with failed implants.

## BIRTHE VENO KJELLERUP (cont.)

*Selected Publications*:


Kjellerup B.V, Kjeldsen K, Lopes, F, Abildgaard, L. Ingvorsen K, Frølund B, Sowers, K. Nielsen P.H. (2009) Biocorrosion and biofilm formation in a nutrient limited heating system subjected to alternating microaerophilic conditions. *Biofouling* 25(8): 727-737.

Kjellerup B.V, Olesen B.H, Nielsen J.L, Sowers, K. R, Nielsen P.H. (2008) Spatial distribution of bacteria involved in cathodic depolarization and stainless steel surface corrosion". *J. Appl. Microbiol.* 105(6): 2231-2238.

May H.D, Miller G.S, Kjellerup B.V, Sowers K.R. (2008) Dehalorespiration with polychlorinated biphenyls by an anaerobic ultramicrobacterium. *Appl. Environ. Microbiol.* 74(7): 2089-2094.

Kjellerup B.V, Xueli S, Ghosh U, May H, Sowers, K. (2008) Site specific microbial communities in three PCB-impacted sediments are associated with different in situ dechlorinating activities. *Environ. Microbiol.* 10(5): 1296-1309.

Kjeldsen, K, Kjellerup B.V, Frølund B, Lorenzen J, Nielsen J.L, Nielsen P.H, Ingvorsen K. (2007) Characterisation of bacterial communities in biofilms grown on metal surfaces in an alkaline district heating system. *FEMS Microbiol. Ecol.* 61(2): 384–397.

Kjellerup, B.V., Gudmonsson G, Sowers K, Nielsen P.H. (2006) Evaluation of analytical methods for analyzing the distribution of biofilm and active bacteria in a commercial heating system. *Biofouling* 22(3): 133-139.

Kjellerup B.V, Thomsen T.R, Nielsen J.L, Olesen, B.H, Frølund B, Nielsen P.H. (2005) Microbial diversity in biofilms in corroding heating systems. *Biofouling* 21(1): 19-29.

Kjellerup B.V, Veeh R, Sumithraratne P, Thomsen T.R, Buckingham-Meyer K, Frølund B, Sturman P. (2005) Monitoring of microbial souring in chemically treated, produced water biofilm systems using molecular techniques. *J. Ind. Microbiol. Biotechnol.* 32(4): 163-170.

Kjellerup B.V, Olesen B.H, Frølund B, Nielsen P.H. (2004) Potential of biocorrosion in Danish District heating systems. *Materials and Corrosion* 55(7): 543-547.

Olesen B.H, Lorenzen J, Kjellerup B.V, Nielsen P.H, Frølund B. (2004) MIC mitigation in a 100 MW district heating peak load unit. *Wat. Sci. Technol.* 49(2): 99–105.

Kjellerup B.V, Olesen B.H, Nielsen J.L, Frølund B, Ødum S, Nielsen P.H. (2004) Monitoring and characterisation of bacteria in corroding district heating systems using fluorescence *in situ* hybridisation and microautoradiography. *Wat. Sci. Technol.* 47(5): 117-122.

## JUDITH R. LEVIN

*Research Interests*: Biochemistry of Protein-DNA Interactions, Structure-Function Relationships in Transcription Complexes of *E. coli* RNA Polymerase, Nucleic Acid Structure and Enzymology

*Research in Progress*:

The expression of genes in living cells is carried out by proteins which can recognize and bind to specific nucleotide sequences in DNA. These proteins then act in various ways to extract genetic information from the DNA in a highly regulated manner. My research focuses in general on understanding the mechanisms by which DNA-binding proteins are able to recognize specific signals in DNA and carry out their specific functions. Recognition may involve chemical as well as structural features of DNA, such as its ability to be deformed into bent or kinked conformations. These features of DNA may also play important roles in the subsequent action of DNA-binding proteins during gene expression. My experimental approach uses biochemical techniques to investigate the structures of protein-DNA complexes in order to gain insight into the mechanisms by which they function.

Of particular interest to me is an enzyme called RNA polymerase, which binds to DNA and moves along it, transcribing the genetic information in the DNA into a corresponding RNA molecule. While the structure of RNA polymerase and its complexes with DNA and RNA are known, very little is known about the mechanics, dynamics or regulation of this structure as RNA polymerase progresses along the DNA during elongation of an RNA transcript. In my lab we use gel electrophoresis to analyze the movement of RNA polymerase along DNA molecules. By studying the effects of changes in DNA sequence and structure and of mutations in the parts of RNA polymerase that contact the DNA on this process, we hope to contribute to the overall understanding of how this biological "machine" may be regulated in living cells.

*Representative Student Independent Research Projects:*

| | |
|---|---|
| Valerie Tucker | Effects of Systematically Varied Phased A-tract Sequences on Elongation by *E. coli* RNA Polymerase. |
| Chandana Lanka | Studies of RNA Chain Elongation by *E. coli* RNA Polymerase in Transcription Elongation Complexes Reconstituted on DNA Oligonucleotide Templates. |
| Laura Marino | Construction and Purification of a Mutant *E. coli* RNA Polymerase Altered in a Region that Contacts Downstream DNA. |
| Carolyn Mochel | The Effect of DNA Bending on Transcription by Bacteriophage RNA Polymerases: Template Construction and Preliminary Analysis |

*Representative Publications:*

Levin, J.R., Krummel, B. and Chamberlin, M.J. (1987) Isolation and Properties of Transcribing Ternary Complexes of *Escherichia coli* RNA Polymerase Positioned at a Single Template Base. *J. Mol. Biol.* 196: 85-100.

Levin, J.R., Burkhoff, A.M. and Tullius, T.D. (1991) "Using the Chemistry of the Hydroxyl Radical to Determine Structural Details about DNA and Protein-DNA Complexes". In *A Laboratory Guide to In Vitro Studies of Protein-DNA Interactions* (J.P. Jost and H.P. Saluz, eds.), *Biomethods (Birkhauser Verlag*) 5: 133-144.

Dixon, W.J., Hayes, J.J., Levin, J.R., Weidner, M.F., Dombroski, B.A. and Tullius, T.D. (1991) Hydroxyl Radical Footprinting of Protein-DNA Complexes. *Meth. Enzymol.* 208: 380.

Draganescu, A., Levin, J.R. and Tullius, T.D. (1995) Homeodomain Proteins: What Governs Their Ability to Recognize Specific DNA Sequences? *J. Mol. Biol.* 250: 595-608.

Levin, J.R., Blake, J.J., Ganunis, R.A. and Tullius, T.D. (2000) The Roles of Specific Template Nucleosides in the Formation of Stable Transcription Complexes by *Escherichia coli* RNA Polymerase. *J. Biol. Chem.* 275: 6885-6893.

Wang, Q., Tullius, T.D. and Levin, J.R. (2007) Effects of Discontinuities in the DNA Template on Abortive Initiation and Promoter Escape by *Escherichia coli* RNA Polymerase. *J. Biol. Chem.* 282: 26917–26927.

## JANET C. SHAMBAUGH

*Research Interests:* Differentiation, morphogenesis, and pattern formation in the vertebrate limb

*Research In Progress:*

Using the embryonic mouse or chick limb bud as model systems, many diverse developmental questions can be approached. Starting with an interaction between two cell layers, the limb bud grows out, cells differentiate into specific tissues, and a pattern of skeletal elements is laid down in a cartilage model. The same processes reoccur in salamanders during regeneration of limbs. One approach we use to understanding these processes involves *in vitro* culturing of limb bud cells in conditions that allow differentiation into cartilage cells. In a culture system we are able to add specific growth factors and then characterize the effect on transcription factors and cartilage formation. The sequence of molecular events that leads a cell into the cartilage pathway begins when transcription factors that specify the cartilage phenotype are placed into action. These factors and the cascade of subsequent events are becoming better understood in this way.

Another approach to studying limb development uses mutations that are natural or created. Gene targeting creates mutations in known genes and gene trapping creates mutations in novel genes. Novel genes expressed in developing limb buds can be cloned and sequenced when tagged by the gene trap construct. The mutations are carried in cell lines, but can be introduced into very early embryos to transform the host embryo into a mutant. One such trapped gene called CtBP-2 is expressed in cartilage and the nervous system. We are currently characterizing its function during embryogenesis of the formation of limb skeletal and joints.

*Representative Student Independent Research Projects:*

| | |
|---|---|
| Lundeberg, Megan | Role of mCTBP2 in joint development of the murine limb |
| Sahyoun, Cyril | PPAR-delta: a possible downstream target of the transcriptional corepressor, CtBP2, in *Mus musculus* |

JANET C. SHAMBAUGH (cont.)

| | |
|---|---|
| Gensheimer, Jennifer | Effects of retinoic acid on embryonic chick limb bud chondrogenesis |

*Representative Posters or Publications:*


Shambaugh J, Siegel R, (2009) Sonic hedgehog and BMP2/4 effect CtBP2 expression in embryonic murine limb mesenchyme, Abstract for poster presentation at the annual meeting of the Society for Developmental Biology, San Franscisco

Shambaugh JC, Lundeberg MR (2006) mCTBP2 Is Expressed at Developing Joints in Murine Limb, Abstract for poster presentation at the annual meeting of the Society for Developmental Biology, June 17-21, University of Michigan, Ann Arbor, MI

Shambaugh JC, Trustman A, Ridolfi T, Wagner MK, Lyons GE (1999) mCtBP2 is essential for normal limb and cardiovascular development. Abstract for poster presentation at the annual meeting of the Society for Developmental Biology, University of Virginia, Charlottesville, VA

Baker RK, Haendel MA, Swanson BJ, Shambaugh JC, Micales BK, Lyons GE (1997) *In vitro* preselection of gene-trapped embryonic stem cell clones for characterizing novel developmentally regulated genes in the mouse. *Develop. Biol.* 185: 201-214.

## ROBERT D. SLOCUM

*Research Interests:* Plant physiology, adaptation of plants to environmental stresses, nitrogen metabolism in plants, plant molecular biology and biotechnology.

*Research In Progress:*

Pyrimidine nucleotides required for DNA and RNA synthesis and cell division in all organisms. In plants, pyrimidine-activated intermediates (UDP-sugars) are essential for the biosynthesis of sucrose, constituents of high-energy foods, and cellulose and related polysaccharides, sources of fiber (clothing, paper, etc.) that account for much of the earth's biomass.

Pyrimidine nucleotide levels in living organisms are regulated by *de novo* synthesis, "salvaging" of preformed nucleobases or nucleosides, and catabolism. The mechanisms by which the pyrimidine metabolism is regulated in plants are poorly understood. Using the model plant *Arabidopsis thaliana*, we are investigating the coordination of synthesis, salvaging and catabolic pathways, using microarray technology to study "global" changes in gene expression, in response to treatments which alter pyrimidine metabolism. These studies have been useful in identifying potentially regulated steps in each pathway. Functional analyses of smaller numbers of genes and their enzyme products are being conducted using RNAi "knockdown" and T-DNA "knockout" mutants, gene "reporter" assays, studies with inhibitors or labeled precursors, etc. This work has the potential to greatly expand our understanding of how pyrimidine metabolism is coordinated with purine nucleotide metabolism and related processes, such as arginine biosynthesis, in plants.

*Representative Student Research Projects:*

| | |
|---|---|
| Matt Hewitt '04 | Pyrimidine Availability Regulates Expression of *Arabidopsis* UPS1 and UPS2 Transporters |
| Caren Bartosz ' 07 | Functional Characterization of the Pyrimidine Catabolism Pathway in *Arabidopsis* |

ROBERT D. SLOCUM (cont.)

*Representative Student Research Projects:*

| | |
|---|---|
| Geoff Ecker '08 | Genetic Regulation of Arginine Biosynthesis in *Arabidopsis* |
| Caroline Maloney '09 | Functional Characterization of *Arabidopsis* Dihydropyrimidine Dehydrogenase |

*Selected Publications* (Student authors are underlined):


Williamson CL, Lake MR and Slocum RD (1996) Isolation and characterization of a cDNA encoding a pea ornithine transcarbamoylase and comparison with other transcarbamoylases. *Plant Mol. Biol.* 31: 1087-1092.

Slocum RD, Nichols HF, III and Williamson CL (2000) Purification and characterization of Arabidopsis ornithine transcarbamoylase (OTCase), a member of a distinct and evolutionarily-conserved group of plant OTCases. *Plant Physiol. Biochem.* 38: 1-10.

Bassett ET, Bouchet BY, Carr JM, Williamson CL, and Slocum RD (2003) PALA-mediated pyrimidine starvation increases expression of aspartate transcarbamoylase (*pyrB*) in *Arabidopsis* seedlings. *Plant Physiol. Biochem.* 41: 695-703.

Schmidt A, Su Y-H, Kunze R, Warner S, Hewitt M, Slocum RD, Ludewig U, Frommer WB, Desimone M (2004) UPS1 and UPS2 from *Arabidopsis* mediate high affinity transport of uracil and 5-fluorouracil. *J. Biol. Chem.* 279: 44,817-44,824.

Hewitt MM, Carr JM, Williamson CL, Slocum RD. (2005) Effects of phosphate limitation on expression of genes involved in pyrimidine synthesis and salvaging in *Arabidopsis*. *Plant Physiol. Biochem.* 43: 91-99.

Slocum RD (2005) Genes, enzymes and regulation of arginine synthesis in plants. *Plant Physiol. Biochem.* 43: 729-745.

Chen CD and Slocum RD (2008) Expression and functional analysis of aspartate transcarbamoylase and role of *de novo* pyrimidine synthesis in regulation of growth and development in *Arabidopsis*. *Plant Physiol. Biochem.* 46: 150-159. (doi:10.1016/j.plaphy.2007.10.016)

Zrenner R, Koppe C, Lange PR, Geserick C, Riegler H, Bartosz CE, Chen CT, and Sloum RD (2009) A functional analysis of the pyrimidine catabolic pathway in Arabidopsis. *New Phytologist* 183: 117-132. (doi: 10.1111/j.1469-8137.2009.02843.x)