

THE HANDBOOK
GRADUATE FIELD OF
GENETICS AND DEVELOPMENT

CORNELL
U N I V E R S I T Y

(Revised July 8, 2009)

THE PH.D. PROGRAM IN GENETICS AND DEVELOPMENT

The Graduate Field of Genetics and Development at Cornell University offers advanced training leading to the Ph.D. degree. The research activities of faculty members in the Field encompass a wide range of areas including gene regulation in bacteria, unicellular and higher eukaryotes (both plant and animal), population genetics, molecular evolution, developmental biology, and developmental genetics. A brief description of each faculty member's research is listed below.

FACULTY OF THE FIELD OF GENETICS AND DEVELOPMENT

Areas of Interest (see <http://www.cals.cornell.edu/MBG/GandD.cfm>)

- Eric E. Alani:** Genetic and biochemical studies in *Saccharomyces cerevisiae* aimed at understanding the role of DNA mismatch repair in maintaining genome stability.
- Charles F. Aquadro:** Molecular population genetics and molecular evolution in *Drosophila* and humans; distribution of recombination within and between genomes and its evolutionary consequences; microsatellite sequence variation and evolution; evolution of genes involved in reproduction.
- Daniel Barbash:** Genetic, molecular evolutionary and developmental studies of speciation and interspecific divergence in *Drosophila*.
- Ronald Booker:** Insect developmental neurobiology.
- Anthony P. Bretscher:** Integration of cell signaling, cytoskeletal organization, and membrane traffic in the functional polarity of yeast and animal cells.
- Edward Buckler:** Genomics, quantitative genetics, and bioinformatics of maize.
- Carlos Bustamante:** Computational genomics, population genetics, molecular evolution, and Bioinformatics
- Jonathan Butcher:** Mechanobiology of embryonic development, regeneration, tissue engineering, and developmental redux in aging.
- Andy G. Clark:** Population genetics, evolutionary genomics, genetics of complex traits.
- Paula Cohen:** Studies of mammalian meiosis and germ cell development, and the role of DNA mismatch repair proteins in these processes.
- David L. Deitcher:** Mechanisms underlying neurotransmitter release in *Drosophila*.
- Scott Emr:** Cell signalling and membrane trafficking in yeast.
- Thomas D. Fox:** Control of mitochondrial and nuclear genes in yeast.
- Maria Garcia-Garcia:** Genetic control of morphogenesis: regulation of cell motility during embryonic development in mice and flies.
- Michael L. Goldberg:** *Drosophila* genetics: Genes required for proper chromosome segregation and morphology.
- Zhenglong Gu:** Structure of metabolic network shaped over evolutionary time by selective pressures using yeast a model.
- Maureen R. Hanson:** RNA editing in plant organelles; genetics of nuclear/organelle and organelle/organelle interactions.
- Richard G. Harrison:** Evolution; population genetics; molecular evolution.
- Susan A. Henry:** Genetics regulation, phospholipid biosynthesis in yeast, transcriptional regulation, signal transduction.

- Jian Hua:** Molecular genetics of temperature responses and defense responses in *Arabidopsis thaliana*
- Tim C. Huffaker:** Microtubule assembly and function and yeast cells/mechanisms of chromosome segregation.
- Kenneth J. Kempthues:** Patterning in early development of *C. elegans*; establishment of polarity; control of cleavage pattern.
- Douglas C. Knipple:** Structure, function, and evolution of proteins that influence insect behavior.
- W. Lee Kraus:** Transcriptional activation by nuclear hormone receptors and coactivators; chromatin and transcription; regulation of gene expression.
- Brian Lazzaro:** Population and molecular genetic approaches to understand how insects adapt to selective pressures imposed by pathogenic microbes.
- Sylvia Lee:** Molecular genetics of longevity in *C. elegans*.
- David Lin:** Axon guidance and target formation during the development of the mouse olfactory system using genetics, *in vitro*, and genomic approaches.
- John T. Lis:** Gene regulation and chromatin structure.
- Jun "Kelly" Liu:** Molecular genetics of mesodermal cell fate specification in *C. elegans*; Function of nuclear envelope proteins in *C. elegans* development.
- Ross J. MacIntyre:** Genetic analysis of metabolic enzyme and structural protein complexes essential for flight muscle function in *Drosophila*; analysis of the structure and function of the complex *dumpy* gene in *D. melanogaster* and other Dipteran species.
- Jason Mezey:** Mapping quantitative loci, pathway modeling, microarray analysis, evo-devo.
- June B. Nasrallah:** Molecular genetics of self-incompatibility in plants; receptor-mediated signaling in plant cell-cell recognition.
- Drew M. Noden:** Craniofacial development in vertebrate embryos; mechanisms of cell migration, angiogenesis, myogenesis.
- Colin R. Parrish:** The evolution of parvoviruses and the viral molecular and cellular basis of the control of viral host ranges by the viral capsid structure.
- Joseph Peters:** Molecular mechanisms of genome stability and evolution; transposons that target DNA replication and DNA repair.
- Jeffrey Pleiss:** RNA processing in budding and fission yeasts.
- Ling Qi:** Unfolded protein response and genetic control of inflammation in obesity and diabetes in mice.
- Shu-Bing Qian:** Nutrient sensing mechanism, protein homeostasis and adaptive stress response.
- Eric Richards:** Epigenetics; DNA methylation; nuclear organization.
- Jeffrey W. Roberts:** Regulation of gene expression in phage lambda; positive control of transcription; regulation of DNA repair.
- John Schimenti:** Genetics of Reproduction and Development in Mice
- Jeffrey Scott:** The genetics, molecular biology and biochemistry of insecticide resistance; insect cytochrome P450s.
- Adam Siepel:** Bioinformatics; comparative genomics; evolutionary genomics.
- Paul Soloway:** Mechanisms regulating DNA methylation and other epigenetic phenomena in mice; role of extracellular matrix remodeling factors as regulators immune responses; functional genetic analysis using gene targeting in mice.
- Nathan Sutter:** Genes that contribute to differences in body size in the dog and gene variants that make dogs susceptible to cancer and other diseases
- David B. Stern:** Regulation of plant organelle gene expression; nucleic acid-protein interactions; nuclear-cytoplasmic interactions.

Tudorita Tambar: Understanding the molecular mechanisms involved in governing stem cell function in mouse tissue.

Bik-Kwoon Tye: Genome structure and DNA replication in yeast.

Volker M. Vogt: Structure and assembly of retroviruses.

Haiyang Wang: Molecular, cellular and biochemical mechanisms regulating plant response to light, using *Arabidopsis* seedling photomorphogenesis as a model system.

Robert Weiss: Genome maintenance mechanisms; cellular and molecular responses to DNA damage; mouse models of human cancer.

Mariana F. Wolfner: Molecular genetics of seminal fluid proteins that influence the mated *Drosophila* female's behavior, sperm storage, and life span; the role of the nuclear envelope in *Drosophila* egg activation, fertilization, and embryonic mitotic divisions.

Responsibilities of Field Membership and Applying to the Field

The primary responsibility of Genetics and Development field members is to train and supervise graduate students in the program. As part of this responsibility, they are required to participate in admissions, recruitment, field meetings, graduate student evaluations, and the teaching of BioGD780, 781 (Topics in Genetics and Development) and 784 (Introduction to Quantitative Analysis). A typical field member organizes a BioGD780 course once every 10-15 years and is on the admissions committee once every few years. BioGD781 and BioGD784 are team-taught courses. Approximately one third of the field members participate in these classes in a given year.

Junior and senior faculty, including those who have been on campus for less than one year, can apply for provisional membership to the Field of Genetics and Development. To apply, an introductory letter should be sent to the Director of Graduate Studies stating the faculty member's interests in joining the field as well as how he/she would contribute to it. In addition, the applicant should provide his/her curriculum vitae and a brief summary of research and teaching interests.

Provisional membership is subject to approval by the G&D Steering Committee (see below). Once approved, the faculty member will immediately be given provisional membership with all of the responsibilities and opportunities of full membership with the exception that he/she cannot serve as the major advisor for a Genetics and Development graduate student until he/she becomes an official member. In addition, he/she cannot vote on Field issues. The provisional member is expected to present a field seminar shortly after applying to the Field.

The responsibilities for provisional membership include giving rotation talks to first year graduate students, participating in BioGD781, a team taught course for first year graduate students, and participating in graduate student admissions and recruitment weekend activities. A formal vote for full membership into the field will take place within a year of provisional membership.

Note: New faculty hired into the Department of Molecular Biology and Genetics must also follow this procedure.

Steering Committee

The Field of Genetics and Development is overseen by a steering committee consisting of the program director, the director of graduate studies, the admissions committee chair, the chair (or Associate chair) of the Department of MB&G, and three additional tenured faculty members. The committee will meet at least once a year to evaluate existing policies and compliance with those policies, implement new programs aimed at strengthening academic standards and student-faculty interaction, monitor progress of senior students and review faculty membership in the training program. Currently the committee consists of Ken Kempthues (Training Grant Program Director and Chair of Molecular Biology and Genetics), Paul Soloway (Director of Graduate Studies), Dan Barbash (Admissions Chair), Tom Fox, and Maureen Hanson.

Approval of Field Proposals

A majority of all Field members must vote in favor of a measure involving Field policy in order for it to take effect.

Policy on Participation in the Training Program Supported by NIH

Field membership does not automatically qualify faculty members to participate in the training program funded by NIH. Participation as a trainer requires active status as a member of the Field of Genetics and Development and requires that the trainer will have had external research support within the past three years. Active status includes participation in training of graduate students by willingness to serve as major or minor advisor to trainees, and participation in laboratory rotations, teaching and other programmatic activities. The steering committee will evaluate past performance of trainers at the time of application for competing renewal of the grant and remove inactive trainers from the program roster.

THE GRADUATE PROGRAM

SPECIAL COMMITTEES

One of the most important decisions made by a graduate student at Cornell involves the selection of the Special Committee. The progress of each graduate student is guided and supervised by the Special Committee, which consists of the thesis research supervisor, also called major professor (Chair of the committee) and two faculty members, one of whom represents the minor subject chosen by the student (see below). Students assemble a Special Committee at the end of the first year, but are encouraged to begin seeking the advice of possible committee members earlier, since much of the student's coursework is taken during the first year. To provide students with adequate advice during the first year, each incoming student is assigned a temporary faculty adviser with whom the student should discuss coursework to be taken that year.

Graduate students in the Field of Genetics and Development may choose as their concentration either genetics or development. In addition, each student must choose one minor subject. The minor is often biochemistry or plant molecular biology. Other possibilities are genetics, development, microbiology, evolutionary biology, cell biology, plant biology, plant

molecular and cell biology, neurobiology and behavior, biometry (computational biology concentration), or a number of other possible subjects. You are not limited to one minor. Note, however, that you cannot major and minor in the same subject (e.g., genetics). Each year the Graduate School publishes a list of major and minor subjects and concentrations for all graduate fields at Cornell. This list can be obtained from the Graduate School in Caldwell Hall, the Graduate Field Office (107 Biotech), or can be viewed on the Graduate School web site at <http://www.gradschool.cornell.edu/>.

The Special Committee system offers great flexibility to the Ph.D. program since it permits tailoring of the program to your specific interests. We encourage you to talk to other graduate students and faculty and to seek as much information as possible before selecting your committee members. Make an appointment to meet with each potential committee member and bring relevant materials to the meeting (e.g., curriculum vitae, course records, and summary of research plans if possible). Be prepared to discuss why he or she would be an appropriate committee member. It is important that both understand each other's expectations: What courses will they require, can they help with certain experiments, etc.

Once your committee has been selected, don't panic if you realize as your research program develops that someone else might be more appropriate. Remember, you are responsible for putting together a committee that best suits your needs. A "Special Committee Selection and Change" form is available from the Graduate Field Assistant, or from the Graduate School web site at <http://www.gradschool.cornell.edu/>. Although it is easier to make committee changes before the Admission to Candidacy exam, it is possible to do so afterward as long as the new member accepts (in writing) the results of your exam.

Special Committee Meetings

You are required to meet with your entire committee at least once a year to discuss progress and plans. It is the student's responsibility to arrange the meeting. Meeting soon after your Wednesday Field Seminar is a particularly good time. Remember to notify your committee of such seminars. The Field distributes your yearly progress report to your committee to help keep them abreast of your progress, problems, plans and successes. Regular meetings with the full committee (a minimum of once a year) will help keep your program on track and can help avoid those awful moments at your defense when a committee member asks why you did not do this control or that experiment. You can also meet with them individually along the way. Use your committee for guidance and feedback. That's why they are there.

It is strongly recommended that senior students present a "final-year plan" to their committee. This does not need to be a formal document, but should include a short outline of experiments that they still plan to do as well as a proposed timeframe for graduation.

TEACHING

All graduate students in the Field of Genetics and Development are required to participate in teaching for one semester and are encouraged to apply for a second semester position in the Department of Molecular Biology and Genetics or in another department. Most students

supported as TAs serve as teaching assistants for the undergraduate Genetics course, BioGD281. Doing so strengthens and broadens their genetics background and thus serves as a good base for graduate training. Other students serve as teaching assistants for one of the other courses offered by the Department of Molecular Biology and Genetics.

G&D students should take their teaching duties seriously. Teaching performance is evaluated by the undergraduates in the courses and reviewed by the teaching faculty of the department. This review becomes a part of the graduate record and is included in consideration for subsequent support (i.e., Training Grant Fellowships). Furthermore, demonstrated excellence in teaching (communication skills) will greatly strengthen your future applications for jobs, both inside and outside academia.

REQUIRED COURSEWORK - EFFECTIVE 2006-2007 ACADEMIC YEAR

The Field of Genetics and Development (see **Sections I-VII below**) requires graduate students to take one semester of BioGD781, one semester of BioGD784, three courses in a breadth requirement, two semesters of BioGD780, a course on ethical issues in science (e.g., BioBM751, Ethical Issues and Professional Responsibilities), and attend and participate in the Wednesday Field Seminars (12:20 pm; BioGD786). Attendance at Friday Molecular Biology & Genetics Seminars (4:00 pm; BioGD787) is also required. Additional course requirements, including the graduate minor, are set by the members of the student's Special Committee. **Grades below B- in a student's major area, however, do not constitute satisfactory performance. Students are strongly encouraged to complete their breadth and minor requirements by the end of their first year. See sample on pages 10-11.**

I. BioGD781 (2 credits), Problems in Genetics and Development, a problem solving course. All entering students take this course in the Fall semester of their first year. It meets every Tuesday once a week; each week's discussion is led by a different professor. The problem sets consist of guided critical reviews of instructive and informative research papers, and expose you to a diversity of topics and approaches in genetics and development. Weekly problem sets and papers are handed out a week in advance; written answers are turned in the following week and discussed with the faculty member in charge of that particular week.

II. BioGD784, Introduction to Quantitative Analysis. (1 credit). This workshop-type course will meet for two hours once a week for six weeks in the fall semester and will be taken by first year students. The course will be completed before students start their first rotation. The goal of this workshop is to introduce bioinformatic and probability/statistical tools at an intuitive level that will be meaningful to first year students.

III. BioGD780 (1 credit, S/U only), Current Topics in Genetics and Development, a seminar course. Students will be required to take two BioGD780 courses, with at least one of the BioGD780's focusing on material presented by each week's MB&G seminar speaker (see below). BioGD780 stresses presentation skills; generally, each student presents one seminar per course based on current research literature in the course topic. Students will be given formal feedback on their presentation by course instructors. This course is led by a different faculty member each

semester so that the focus varies. The Graduate Field Assistant can tell you what faculty member will be responsible for a given semester.

Two to three BioGD780 courses are offered each year, one to two of which are focused on a specific topic, and one is focused on the MB&G seminar series. For the BioGD780 focused on the MB&G seminar series, the student's presentation should be designed to encourage discussion of experiments performed by the speaker and his/her field of interest.

IV. BioBM751 - Ethical Issues and Professional Responsibilities, a discussion course. All incoming students are required to take this or a comparable course in scientific ethics. BioBM751 is offered in the Spring semester. The opportunity to discuss these issues openly will be an important and valuable part of your graduate training.

V. BioGD786 and BioGD787 - All post-first year students sign up for one credit of BioGD786 (in-house seminar series) and one credit of BioGD787 (invited seminar series) each semester. First year graduate students only sign up to audit these two courses.

VI. Breadth requirement. Students are to take a minimum of three courses from the list below (categories A-E) with at least one course taken from each of three separate categories. A course in category A may be exempted with the approval of the DGS if the student has already taken a similar statistics course. The Field recommends that a student with limited background in a particular category take a course in that grouping that stresses fundamental concepts. Note that classes that a student takes in the new breadth requirement can count towards the minor requirement.

A. Statistics

BTRY601 Statistical Methods (F)

B. Biochemistry, Molecular, and Cellular Biology

BIOBM437 Cell Proliferation and Senescence (S)

BIOBM439 Molecular Basis Of Human Disease (F)

BIOBM631 Proteins: Structure, Function and Dynamics (F)

BIOBM633 Biosynthesis of Macromolecules (F)

BIOBM639 The Nucleus (S)

BIOBM636 Functional Organization of Eukaryotic Cells (S)

BIOPL444 Plant Cell Biology (F)

BIOPL462 Plant Biochemistry (S)

C. Genetics

BIOGD486 Advanced Eukaryotic Genetics (S)

BIOGD485 Bacterial Genetics (F)

BIOGD400 Genomics (F)

BIOGD608 Epigenetics (F)

PLBR 606 Advanced Plant Genetics (S)

D. Population Genetics and Evolution

- BIOGD481 Population Genetics (F)
- BIOGD484 Molecular Evolution (S)
- BIOGD487 Human Genomics (F)
- BTRY 683 Quantitative Genomics and Genetics (S)
- BIOEE480 Ecological Genetics (S)

E. Development

- BIOGD440 Stem Cell Biology: Basic Science and Clinical Applications (S)
- BIOGD450 Vertebrate Development (F)
- BIOGD461 Development and Evolution (S)
- BIOGD489 Mammalian Embryology (S)
- BIOGD687 Developmental Genetics (F)
- BIOPL422 Plant Development (S)

VII. Minor Requirement in One Subject Area: You should discuss with potential committee members the requirements of the program in which you plan to minor since some have quite specific course requirements. Below are the current requirements for several of the common minors. In general, completion of the minor requires at least two courses at the 400 level or higher. You are urged to discuss, as soon as possible, how you will satisfy the minor requirements with both the prospective committee member and if necessary with the DGS for the field under which the minor is administered.

1) Development (Field of Genetics and Development) - requires two courses in Development (see below) that are beyond BioGD385. Note that BioGD385 should be taken in addition to these two courses if a student lacks the appropriate background. Participation in a weekly Developmental Biology Journal Club is strongly encouraged (see Journal Clubs).

2) Genetics (Field of Genetics and Development) - has no formal requirements; individual course requirements may be specified by your committee members (usually 2 or 3 advanced courses at the 400 level or above and BioGD281, if necessary).

3) Biochemistry (Field of Biochemistry, Molecular and Cell Biology) - requires 6 or more credits of advanced course work. Some suggestions for appropriate courses: BioBM437, 439, 631, 632, 633, 636, 638, 639, 738 and Chem668, 672, and 677. The 6 credits can be put together in any way that satisfies the BMCB faculty member representing the minor. If the student's lab background in this area is weak, the BMCB faculty committee member may require that the lab course BioBM440 also be taken. He/she might also approve a course not offered by BMCB but still relevant, including any of the one-half credit minicourses.

4) Cell Biology (Field of Biochemistry, Molecular and Cell Biology) - same requirement as for Biochemistry minor (above).

5) Microbiology (Field of Microbiology) - the requirements for a minor in Microbiology are ultimately up to the discretion of your minor advisor. Generally, students are expected to complete at least two of the five one-credit modules in Microbiology (BioMI690). The Modules

in Microbiology include Microbial Structure and Function, Microbial Genetics, Microbial Pathogenesis, Microbial Physiology and Diversity, and Environmental Microbiology.

6) Plant Molecular Biology (Field of Plant Biology) - completion of three 1-credit sections of BioPL653 and 652 (including BioPL653, Section 01, Concepts and Techniques in Plant Molecular Biology) with a grade of B- or better, as well as satisfactory completion of two other courses to be selected by the minor advisor in either a plant-related area or in genetics, biochemistry, or cell biology. Satisfactory participation in the Plant Molecular Biology Journal Club for two semesters is also required (BioPL742, Current Topics in Plant Molecular Biology).

7) Plant Cell Biology (Field of Plant Biology) - satisfactory completion of Plant Cell Biology (BioPL444) or Survey of Cell Biology (BioBM432), and the following three 1-credit sections of BioPL652: Section 5/Molecular Biology of Plant Organelles, Section 6/Proteomics in Plant Biology; and Section 7/Plant Cell Walls: Structure to Proteome) or alternative courses as approved by the minor advisor.

8) Evolutionary Biology (Field of Ecology and Evolutionary Biology) - no specific requirements. Discuss expected background with your prospective minor committee member.

9) Genomics (Minor Field) - requires BioGD400, BioGD401, and two one credit modules in the minor curriculum, or other qualifying courses, as approved by the Special Committee.

10) Biometry (Field of Biometry) - discuss course work with your prospective minor committee member.

11) Computational Biology (Field of Computational Biology) - discuss course work with your prospective minor committee member.

12) Neurobiology and Behavior (Field of Neurobiology and Behavior) - discuss course work with your prospective minor committee member.

A sample schedule in the new system for a Development Minor:

Fall Year 1

1. BioGD781/BioGD784
2. BioGD487 Human Genomics (category C)
3. BioGD687 Developmental Genetics (category D, also counts for the minor)
4. Rotation/NSF fellowship submission

Spring Year 1

1. BioBM636 Functional Organization of Eukaryotic Cells (category A)
2. BioGD483 Advanced Developmental Biology (minor)
3. BioGD780 or a course of interest, perhaps in the minor.
4. Rotations

Fall Year 2

1. Teaching Fellow
2. BioGD780-coupled to the MB&G seminar
3. Thesis research*

Spring Year 2

1. Teaching Fellow
2. Ethics
3. Thesis research*

Fall Year 3

1. A-exam.
2. Thesis research*

Spring Year 3 and beyond: Thesis research*

*As part of their thesis research, students are expected to participate in lab/department journal clubs.

Please note that there is apparently a long break between the two semesters. However, graduate students are expected to be working on their first or second rotation (see Laboratory Rotations) during the intersession period.

A sample schedule in the new system for a Genetics Minor:

Fall Year 1

1. BioGD781/BioGD784
2. BioGD485 Bacterial Genetics
3. BTRY482/682 Statistical Genomics (category C)
4. Rotation/NSF fellowship submission

Spring Year 1

1. BioGD486 Advanced Eukaryotic Genetics (category B, also counts for minor)
2. BioBM639 The Nucleus (category A)
3. BioGD780 or a course of interest, perhaps in the minor.
4. Rotations

Fall Year 2

1. Teaching Fellow
2. BioGD780-coupled to the MB&G seminar
3. Thesis research*

Spring Year 2

1. Teaching Fellow
2. Ethics
3. Thesis research*

Fall Year 3

1. A-exam.
2. Thesis research*

Spring Year 3 and beyond: Thesis research*

*As part of their thesis research, students are expected to participate in lab/department journal clubs.

REQUIRED COURSEWORK FOR STUDENTS ENTERING CORNELL PRIOR TO THE 2006-2007 ACADEMIC YEAR

The Field of Genetics and Development requires that graduate students take one semester of BioGD781, three semesters of BioGD780, a course on ethical issues in science (e.g., BioBM751, Ethical Issues and Professional Responsibilities), and attend and participate in the Wednesday Field Seminars (12:20 pm; BioGD786). Attendance at Friday Molecular Biology & Genetics Seminars (4:00 pm; BioGD787) is also required. Beginning students are strongly encouraged to take BioGD486, Advanced Eukaryotic Genetics. Additional course requirements are set by the members of the student's Special Committee. **Grades below B- in a student's major area, however, do not constitute satisfactory performance.**

BioGD486 - Advanced Eukaryotic Genetics. The course develops fundamental skills in eukaryotic genetic analysis through lectures and by reading, analyzing, and presenting research articles. Concepts are presented within the context of a well-studied field, such as cell cycle control or protein secretion, and then the basic tools that have been developed to study this field are used to analyze other topics such as vegetative and meiotic cell cycle control, embryonic development, chromosome organization, and protein trafficking.

BioGD781 - Problems in Genetics and Development, a problem solving course. All entering students take this course Fall semester of their first year. It meets every Tuesday once a week; each week's discussion is led by a different professor. The problem sets consist of guided critical reviews of instructive and informative research papers, and expose you to a diversity of topics and approaches in genetics and development. Weekly problem sets and papers are handed out a week in advance; written answers are turned in the following week and discussed with the faculty member in charge of that particular week.

BioGD780 - Current Topics in Genetics and Development, a seminar course. Each student is required to participate for three semesters in this seminar course. It is led by a different faculty member each semester so that the focus varies. Generally, each student presents one seminar per course based on current research literature in the course topic. Topics are announced before the semester begins. The Graduate Field Assistant can tell you what faculty member will be responsible for a given semester.

BioBM751 - Ethical Issues and Professional Responsibilities, a discussion course. All incoming students are required to take this or a comparable course in scientific ethics. BioBM751 is offered in the Spring semester. The opportunity to discuss these issues openly will be an important and valuable part of your graduate training.

BioGD786 and BioGD787 - All post-first year students sign up for one credit of BioGD786 (in-house seminar series) and one credit of BioGD787 (invited seminar series) each semester. First year graduate students only sign up to audit these two courses.

Minor Requirements: Same as for the new curriculum, listed above in Section VII.

SEMINARS

The bulletin board across from the first floor elevator in the Biotechnology Building is the place to check for topics, times and places of talks. Two seminar series that you are required to attend are:

Friday Molecular Biology and Genetics Seminar (BioGD787): 4:00-5:00 pm Fridays during Fall and Spring semesters and occasionally during the Summer in the Biotechnology Building Conference Room. These talks are given by scientists visiting from other institutions and provide an opportunity to hear and meet some of the most distinguished researchers in the areas of genetics and development. Speakers are usually invited and hosted by faculty members, but graduate students can play a significant role in choosing whom to invite. First, students can suggest names of desirable speakers to their major professor, and second, at least once a year graduate students have the opportunity to independently invite and host a distinguished scientist. Very popular speakers who would otherwise be “too busy” will often find time in their schedules if they are invited by students rather than faculty. Coffee, tea and cookies are available at 3:45 pm, and there is usually an informal “Meet the Speaker” Happy Hour immediately after the seminar in one of the lounges upstairs. In addition, there is usually an opportunity for a group of graduate students to take the speaker to lunch on Friday. If you are interested in talking individually with a speaker, see the host listed at the bottom of the seminar notice and he or she will be glad to try to schedule you.

Wednesday Field Seminars (BioGD786): 12:20-1:15 pm Wednesdays in the Biotechnology Building Small Seminar Room. All graduate students and postdoctoral fellows give seminars to present their research progress. **Students join the cycle in their second year and present their work at least once a year.** (Second year students are only expected to give a half hour talk.) You will be given ample notice of the date of your seminar, and must submit a title and short abstract to the Graduate Field Asst. (Room 107) the month before your talk so that it can be distributed to members of the Field. Please note that attendance will be taken at the Wednesday Field Seminars; students are required to attend at least 2/3 of the seminars in order to receive a satisfactory grade in BioGD786.

JOURNAL CLUBS

Participation is on a voluntary basis, but you are encouraged to attend the Journal Clubs in your area of interest. Below are some of the Journal Clubs that meet on a regular basis:

Bacterial Genetics Journal Club – Steve Winans, scw2@cornell.edu

Cell Biology Journal Club – Tony Bretscher, apb5@cornell.edu

Cellular and Molecular Neurobiology Journal Club – Kathie Burdick,
krb3@cornell.edu

Cornell Vertebrate Genomics Meeting – Charlotte Williams, cw25@cornell.edu

Developmental Biology Journal Club – Kelly Liu, jl53@cornell.edu

Environmental Microbiology Journal Club – Esther Angert, era23@cornell.edu

Eukaryotic Gene Regulation Journal Club – John Lis, jtl10@cornell.edu

Molecular Evolution Journal Club – Charles Aquadro, cfa1@cornell.edu

Neuroethology Journal Club – Carl D. Hopkins, cdh8@cornell.edu

Repair, Replication & Genetic Recombination Group – see

<http://www.micro.cornell.edu/r3group/>

Reproductive Biology Journal Club – John Schimenti, jcs92@cornell.edu

Sexual Selection Journal Club – Mariana Wolfner, mfw5@cornell.edu

Virology Journal Club – Colin Parrish, crp3@cornell.edu

Most labs also have their own weekly lab meetings. Students in, or rotating in, the lab attend; others are welcome.

LABORATORY ROTATIONS

Laboratory rotations can be a very effective way for new graduate students to get acquainted with faculty members and their co-workers. They provide an opportunity for graduate students to explore in some depth areas they are considering for their Ph.D. Thesis research. In addition, they allow both graduate students and faculty to test out possible working relationships.

While, in the interests of flexibility, the Field of Genetics and Development does not have formal requirements concerning lab rotations, here are some recommendations for first year graduate students. Early in the Fall semester, you will meet as a group with each of the faculty in the Field to discuss their labs' research. In addition, you should keep your ears open at the Wednesday Seminars, in classes and in the halls, and decide in which laboratories you would like to rotate. You should contact these faculty members as soon as possible to discuss your plans and work out a schedule for the three suggested rotation periods (see below). By mid-October, you should make your plans known to the Director of Graduate Studies (DGS) and to Vicki Shaff, Graduate Field Assistant. Beginning in October of your first year you should start the first of three rotations. Usually, by the end of the third rotation, you will by mutual agreement with the faculty member concerned have settled on a laboratory in which to do thesis research. In unusual cases, a graduate student and a faculty member may agree early on a thesis project. In the interests of breadth such a student is encouraged (though not required) to continue with rotations.

What is expected of a graduate student on rotation? While no one objects to a graduate student completing a project and writing a paper for publication during a rotation, no one expects it either! What is expected is an earnest effort on a project and the fullest participation possible in the intellectual life of the laboratory. If, either before or early during a rotation, a graduate student finds that her or his interests have changed dramatically, she or he should not feel trapped, but rather try to arrange a new rotation elsewhere.

Recommended Rotation Periods:

1. Late October through December
2. Early January to mid-March
3. Mid-March to mid-May

At the end of each rotation, the supervising faculty member prepares a written evaluation that is informally discussed with the student. Both the student and faculty are asked to sign the evaluation form, which is then returned to the Graduate Field Assistant (Vicki Shaff).

VACATION

You are paid on a 12-month stipend, so if you plan on being gone for a significant period of time, you must have the approval of your advisor and notify the Graduate Field Assistant of your intentions.

PROGRESS REPORTS

Annual progress reports are required for all graduate students each year. These reports are used to decide which students to submit for fellowships, training grant slots, or other preferred support. They are also used to keep your committee informed of your progress during the previous year. Forms for the report are distributed by the DGS each spring. The Chair of your committee will be asked to evaluate your progress, show you his/her evaluation and discuss it with you, then give it to you to sign and turn in with your completed progress report form. These will be added to your file and a copy will be given to your committee members.

Students are evaluated each year at a Field meeting held in May. Progress reports, teaching evaluations, rotation evaluations and progress towards degree completion are all considered. Results of the evaluation are communicated to all students by the DGS.

ADMISSION TO CANDIDACY ("A") EXAM

To qualify as a Ph.D. candidate, each graduate student must pass an "Admission to Candidacy" exam (or A-exam), by the end of the fifth semester. The examiners are the members of the student's Special Committee and one other faculty member (to be chosen jointly by the student and thesis advisor). The purpose of the exam is to test the student's level of knowledge and ability to design research strategies.

The examination consists of a written proposal for a research project on a student's thesis project or on an unrelated project, and the student's oral defense of the proposal (the actual A-exam). The format of the proposal should be either that of an NSF or an NIH grant request (**15 double-spaced pages of text, 12-point type or larger-see below for details**). It should explain how the research will answer some important scientific question, or (at least) how the research will rule out some possible answers to an important question. Individual members of the Committee may add special requirements to be included in the proposal; for example, a detailed protocol for mapping a gene involved in the proposal, etc. The major professor is permitted one reading of the proposal prior to submission to the exam Committee. The student must deliver a copy of the completed proposal to each exam Committee member no later than one week before the A-exam. At the A-exam, the Committee will question the student about various aspects of the proposal; but their questions need not be limited to the proposal and should assess the student's ability to analyze and plan experiments in genetics or development, and their knowledge of genetics or development.

Satisfactory defense of the proposal and related questions at the A-exam leads to admission of the student to candidacy for the Ph.D. Failure of the exam leads to one of the

following: A one-time rescheduling of the exam; a decision to terminate the student at the Master's degree level upon completion of a Master's thesis; or dismissal from the program (at the discretion of the student's committee).

As stated above, the A-exam must be taken by the end of a student's fifth semester in graduate school. To ensure that the exam will be completed within this time frame, students will be asked to set an exam date by the beginning of their fifth semester (September 1). Students who have not set a date by this time will have one set by the Director of Graduate Studies.

Genetics and Development graduate students have the option in their second year to take BioBM838, Methods and Logic II (or SOS, Skills of a Scientist), taught by David Shalloway. This course provides a good preparation for the A-exam because assignments are given in which students write and critique grant proposals relevant to their thesis work. In addition, students are taught analytical and statistical skills and are introduced to career paths that are pursued by many of our graduates.

SPECIFIC A-EXAM INFORMATION.

This information was kindly provided by Volker Vogt and Tim Huffaker, Department of Molecular Biology and Genetics.

Format of the exam

The format has a written and an oral component. The written component takes the form of a grant proposal and is described below.

The oral component is a defense of this proposal and you can expect that the majority of questions will be directly related to your proposal or to areas that are considered off-shoots of it. Your committee member representing a minor subject area, however, represents a special case. This person has the responsibility to ascertain that you have achieved competency in that subject area, and the topic of the research proposal may not afford a good opportunity to do this. We recommend that you meet with the person in question, and determine prior to the A exam how he/she suggests you prepare. Some committee members representing minor subject areas may ask broadly-based questions on very basic concepts, whereas others may address a more narrow area and ask the candidate to be prepared for questions in that area.

In addition to the evaluation of your proposal, the A exam is the time when committee members will discuss and evaluate your performance in the laboratory.

The written proposal

Your proposal should be written following the format specified below which is based on the guidelines for NIH grant proposals. Your proposal can be written on a topic that either does or does not relate to your research. In either case, you should enter your A exam with a comprehensive knowledge of the literature in the area you have chosen.

Writing on your research more closely approximates a real life situation, because if you pursue a career in research science, you will have to write many proposals about what you plan to do. The special benefit in writing about your research is that it provides you the opportunity to organize your actual research plan and to dig deeply into the literature in your field.

Writing about a topic unrelated to your research allows you to explore a new area, one that deeply interests you, but one that you do not plan to pursue for graduate research. It may be an area you want to pursue at some later stage in your career. To find an unrelated topic, you might browse through recent journals—especially ones of general interest, like *Science* and *Nature*. Find a problem that really interests you and then decide what unanswered questions are raised by the paper. What techniques could be used to answer them? Pursue these ideas with further reading. If you think you have a topic, a good idea is to discuss it in general terms with someone who might know about this topic, such as a faculty member in this or another department.

Once you have narrowed the topic, develop a few (say three) specific questions you want to answer. Don't write down questions that are too general. By being specific, the questions will keep your proposal focused on the topic. After you have come up with a few specific questions, sketch in outline form what experiments you might do to answer them. Then work through the details to flesh your ideas out as a real proposal.

Your proposal will be judged for its innovation, quality and organization. Your thoughts should be developed logically and should represent some real insight in the field. The exam is meant to challenge your thinking and provoke discussion between you and your examiners. The format does not serve a useful purpose if the proposal and the exam:

1. Simply espouses "the party line" and echoes common themes in the lab (if you are writing on your own research).
2. Does not address interesting issues in the field.
3. Proposes only a small incremental advance in research.
4. Offers only pedestrian solutions to problems.
5. Fails to evoke dialectics and debate.

Finally, matters of writing style and impeccable grammar are absolutely essential for successful proposals. Simple flaws can mar an otherwise perfect proposal. The A exam proposal is an exercise in meeting the highest standards of style and presentation.

More about the specifics of writing your proposal is discussed in a later section.

How much help can you receive in preparing your proposal?

Connecting to others in the research community is essential in competitive research and evidence of your involvement in science. A factor in evaluating your proposal is whether you have made these interconnections. Although you should seek out as much information as you can find about your topic, the major ideas should be yours, as should all the writing, of course. The following guidelines were crafted with the idea of encouraging input from others while at the same time focusing attention on your efforts.

In meeting with a faculty member about your proposal, it is expected that you will describe the general nature of the problem under investigation, the specific questions that you are proposing, and an overview of the approaches that you plan to take. In addition to comments on importance and feasibility, some faculty may provide you with factual material or with references.

Once you have written a complete proposal that contains all of the questions that you expect to pose and all of the experimental approaches you intend to follow, give your proposal to several senior graduate students or postdoctoral fellows and faculty advisor, and ask them for criticism. If they provide you with ideas that you use, give them credit for those ideas. For example, "(latter two controls suggested by Chelsea Clinton)". The criticisms should be general (e.g. "this section is awkward", "this is unclear", "why not expand this section to include related studies?"). No one but you should be doing the actual writing.

Some procedural details

Remember that you need to ask one additional faculty member to join to read your proposal and attend the examination. This person is not officially a member of your committee. The additional faculty member does not necessarily have to be in the Field of Genetics and Development; but if you decide to invite someone other than a Field member, please check first with your major professor.

You should give a copy of your proposal to each member of your examination committee at least a week before the exam.

It is essential that the Graduate School and the Graduate Field Assistant receive a signed copy of the Schedule of Examination form *at least* 7 days prior to the A exam. That form must be signed by the three members of your Special Committee and the Director of Graduate Studies. You must turn in the Results of Examination form within 3 business days after the exam to the Graduate School and the Graduate Field Assistant (GFA). These forms can be obtained from Vicki Shaff, GFA (107 Biotech) or downloaded from the Graduate School web site at <http://www.gradschool.cornell.edu/?p=11>.

Possible outcomes

Some possible outcomes of the A exam are described below. While one of these outcomes will apply in most cases, it should be noted that the final outcome is determined by the Special Committee and they are not limited to the examples given below. Some factors that may be judged in evaluation of the A-exam are:

- importance of the problem chosen
- an introduction that demonstrates a command of the field.
- evidence of creativity in formulating experimental approaches
- feasibility of the proposed experiments
- whether a range of different approaches are brought to bear on the problem
- whether the scope of the proposed experiments is feasible for a three-year project
- adequacy of control experiments
- clarity of the proposal
- ability to deal with questions
- communication / presentation skills
- breadth of knowledge

1. Unqualified pass.

2. Pass conditional on rewriting the proposal. This option will be exercised when the committee judges that the proposal and the defense are adequate but that some aspect of the proposal needs to be improved. The committee may specify that the entire proposal or that parts of it need to be revised. Some reasons for revision are:

- a. The writing needs to be improved (for example, grammar, clarity, or logical flow of ideas).
- b. Some aspect of the science needs to be rethought (for example, better controls, more cautious interpretation, or more detailed description).
- c. An additional section needs to be incorporated into the proposal.

The student is expected to rewrite the proposal within 2 weeks and resubmit it to the examination committee members for approval. The extent to which the major professor wants to be involved in the rewriting is up to him or her.

- 3. Fail.** The student can fail the exam because either the written proposal or the oral defense is judged inadequate. In that case, the committee will usually recommend one of three actions. If the committee has confidence in the overall ability of the student to complete the Ph.D. program, then they may recommend that the student retake the A exam. In this case, they will specify whether an entirely new proposal on a different topic is to be written or whether they expect a major rewriting of the original proposal. Note that the rules of the Graduate School specify that a second A exam cannot be scheduled earlier than 3 months after the first.

If the committee has some question concerning the motivation or ability of the student to complete the Ph.D. program, it will usually recommend that the student complete a piece of research, write a Masters-level thesis based on that work, and then defend that thesis. If the student wants to continue for a Ph.D. degree, and his or her committee judges that the Masters-level work and thesis defense demonstrates qualification, then the thesis defense may be accepted in lieu of an A exam. In some cases, the Special Committee may specify that reentering the Ph.D. program requires retaking the A exam.

If the committee feels that gap between the student's ability/motivation and the expectation of the program is too wide to be bridged, it may recommend dismissal of student from the program.

What can I do to ensure that I pass my A exam?

We have three suggestions:

1. Read several proposals written by former students. Copies of these can be obtained from the Graduate Field Assistant.
2. Read carefully the specifics on writing the proposal, below.
3. If you are worried about being nervous, and having to think on your feet while being nervous, it may help you to have a practice run. You can do this by asking several students to read your proposal and then act as examiners during a mock 2-hour exam.

Remember this: everyone in this field wants you to succeed.

Specifics on writing the proposal

You should follow the format specified below which is based on the format for NIH grant proposals. Strict page limitations are set for grant proposals, and thus also for your proposal. Page limitations are specified below; each page should be double spaced with margins of at least one inch and in a font not smaller than Times 12 point. **The total length of the proposal, including figures, is 15 pages. Literature cited is not included in this page limit.** The proposed work should be limited in scope, so that a postdoctoral fellow (perhaps with the help of a technician) could accomplish the bulk of the work in three years. Study sections that review grants are very critical of proposals that describe five times as much work as could actually be done, even if very good descriptions of experiments are given.

An important section of all grant proposals is the progress report or preliminary data. However, this section is not a deciding element in the A exam, and students should not put off taking an A exam for want of more data. Preliminary data is useful in charting the future course of research; however, the A exam is not intended to judge research accomplishments, but to assess the prospects for research based on the student's ability to conceive, investigate and defend a research proposal.

Here is the format you should follow: (suggested page limits for each section in double spaced text are provided). **Note: Exams that are over the 15 total page limit will be returned to the student so that they conform to page requirements!**

- A. Abstract** (≤ 1 page). This is a summary of the proposed work, with enough of an introduction to allow someone not expert in the field to understand what is planned and to appreciate its importance.
- B. Introduction** (≤ 6 pages). The Introduction is one of the most important sections of your proposal. This section introduces the topic and system, and summarizes what is already known. The review should be comprehensive but not simply be a chronology of events; it should represent a critical appraisal of developments in the field and an evaluation of the present state of affairs. You should cite review articles as well as original research articles that are relevant. If appropriate, unpublished results can be included as a minor component of this section. Other research results that you have may be best incorporated into the Experimental Design and Methods section below. End this section with a clear statement of the overall goal of the work.
- C. Specific Aims.** (≤ 1 page). This section states crisply the hypothesis you are testing, or the questions you will try to answer. It also provides a list of each separate approach (aim) you will use to reach the overall goal. Use subheadings if appropriate (1).
- D. Experimental Design and Methods** (≤ 10 pages). This is the meat of your proposal and should be organized according to the specific aims and presented clearly. Critical experiments should be described so that examiners appreciate your mastery of the subject. Experiments, important controls and contingency plans need to be fully described.

Outline for each of the specific aims (use the same headings and subheadings) how you will proceed to test the hypothesis or answer the question posed. Give enough detail so the reviewer can judge if the experiment is likely to work. You don't need to give details about common procedures since these can be referenced. For example, molecular biological methods that are described in a manual such as *Current Protocols in Molecular Biology* needn't be repeated (buffers, times of incubation, etc.). But if there is a basic protocol you rely on for a large fraction of the work, you should lay it out for the reader. The reviewer is looking for indications that you have carefully thought out every step in the proposed procedure. If you are not sure every step is feasible, so indicate and describe what you will do if the step doesn't work.

There are several types of design problems that occur frequently, both in A exam proposals and in real grant proposals.

1. *Achieving the goal requires finding something.* A favorite criticism of some kinds of proposals is that they are nothing but "fishing expeditions" (by implication, with little chance of catching a big one). Don't plan to spend more than a fraction of your research time seeking something that you may not find (2). Even if the payoff looks large, and if the chances look good, you won't get grant money (at least not at the beginning of your career) if a search is the main thing the proposal is about. Build into the proposal experiments that will yield results no matter how they come out (3).
2. *Too many contingencies.* If achieving a major goal Z requires you first to achieve Y, and Y requires X, and so forth, the probability of reaching the end goal Z may not be high (4).

3. *Limitation of starting material.* Know how much starting material is available, how much this costs to obtain (money or labor), and what size of an operation you would need to work it up to achieve your goal (5).

An important part of the "Experimental Design and Methods" section is a description of how data will be interpreted. This is especially true for quantitative data. No one obtains funding just to make measurements! Grant proposals are frequently criticized because the results obtained will be "purely descriptive" (a favorite phrase of criticism often levied by reviewers). What is the meaning of the data you hope to collect? Being explicit about your interpretations is a key element in convincing the reviewer that the papers you write will make a significant contribution to the field (instead of confusing the field so that others will need to clean up afterwards, as so often happens).

At the end of the "Experimental" section, it is wise to put in a paragraph or two about possible pitfalls. Nothing is guaranteed to work. If you let the reviewer know what you think the major limitations are, then you make clear the fact that you have thought about them. If you anticipate a potential problem, then you should indicate what alternative procedures you will use to get around it (6).

- E. Significance** (≤ 1 page). With the present competition for financial support, it has become crucial to argue that your results will be of importance for answering fundamental questions, or that they will lead to avenues of inquiry, or that they will be of practical relevance to medicine or biotechnology (for example). State succinctly why the taxpayer should support your proposed work.
- F. References.** These should be in the regular journal format, with titles. Twenty five should be enough, although more are often included. Choose them carefully. Just cite the most recent, or the one or two most important references of a series. Use reviews for older literature references, adding "see ___ for review."
- G. Figures and Tables.** Figures and tables are often useful as an aid to the text. It is quite appropriate to reproduce figures from a review or other important article (state clearly from where taken). Figures may also be useful to show the reader what data you expect and how the data will be interpreted. Key figures and tables should be placed in the appropriate positions in the text and they count toward the page limits.

Time required to prepare the proposal

You should plan to spend about one month of full time work to prepare your proposal. Some students can do the background research and then write a thoughtful proposal in three weeks, while some take six weeks. Two months is definitely too long!

General comments on writing

Good writing is an essential component in your quest for funding! If you are famous, you may get a poorly written grant proposal funded. However, most of us have seen funding denied to very well established investigators who have submitted carelessly or poorly written proposals. On the other hand, if you are not well known, given the competition for research funds that exists today, your proposal will almost certainly remain without financial support if it is poorly thought out or poorly written. In a well-written proposal, the eye of the reader moves down the page in an

unbroken manner, from sentence to sentence and paragraph to paragraph. The logic of the presentation is so clear, and the writing so free of distractions, that he almost never has to read a sentence twice. This requires good use of transitions, between sentences (7) and between paragraphs (8). A particularly important principle of good writing that is often neglected is paragraph structure. Each paragraph should have a topic sentence (usually the first sentence) that tells what the paragraph is about. Another principle is to use uniform tense (9). Yet another principle (often mis-taught by teachers of scientific writing) is to avoid overuse of the passive voice (10). Keep in mind that a well-written proposal requires multiple revisions. Each word and sentence should say exactly what you want to say—no more and no less.

Footnotes:

1. One format might be: "The overall aim is to..." , or "The long term goal is to.....", followed by one or a few sentences. Then the actual specific aims could simply be listed, perhaps with subheadings 1. [1a,1b]; 2. [2a,2b,2c]; 3. Often the best way to phrase your aims is in terms of an hypothesis: "The hypothesis to be tested is that....."
2. For example, don't draw up a proposal with the major aim to identify by differential display a cDNA representing a messenger RNA that is produced in mammalian cells in response to growth factor stimulation. That is truly a fishing expedition and there is not much to say about the cDNA until it is found. Or as another example: suppose you want to study what proteins interact with a yeast cytoskeletal protein, by mutating the gene for that protein, and then cloning second site suppressor genes. This is an excellent approach and has many precedents. But even so, the second site suppressors may not be obtainable. Hence, in the absence of direct evidence that this approach is workable in your system, don't put all your eggs in this basket.
3. For example, if you are studying a particular protein that is available in pure form, do some enzymological characterization that will answer an important question, or map functional domains of the protein by mutagenesis—in such cases whatever you find or measure may be useful.
4. For example, suppose you want to study the properties of a very minor cellular protein, say the protein product of the *mos* oncogene. Your plan is to purify the protein, make monoclonal antibodies, use the antibodies to fish out the right gene from a cDNA expression library, hook up the gene to strong inducible promoter, insert this construct into an *E. coli* expression system, induce and finally purify the protein. All these are standard steps, but the chances of success, starting with no knowledge about the protein, are slim. Purifying minor proteins may be difficult (suppose this one is membrane bound and inactivated by detergents). Maybe the protein is not very antigenic in mice. The monoclonals may well not work in the western blot screening procedure. The expressed protein may be toxic even low doses, or it may well precipitate in the cell. Don't base too much of the proposal on such a series.
5. For example, don't propose to grow primary animal cells in culture as a source for a minor protein you want to purify in milligram amounts. Think ahead that one plate of cells, costing roughly a dollar in plastic plus growth medium, contains only a milligram of total protein. Since you would need thousands of plates to obtain enough starting material, this strategy would not be workable.
6. For example, suppose you plan to overexpress a certain foreign protein by introducing the gene into CHO cells along with the gene for dihydrofolate reductase, and then selecting for gene amplification with methotrexate. This is a reasonable procedure, but it might turn out

that the protein is toxic to the cells, and thus production will not be high, or the protein may become mutated to a less toxic form, or the clone may simply not be obtainable. You should anticipate these problems, and indicate if troubles arise, a different eucaryotic expression system (for example baculovirus) will be used instead.

7. A transition can be a word or a phrase or clause showing how what follows relates logically to what came before. For example: "However,..."; "Nevertheless,..."; "In addition,..."; "By contrast,..."; "In order to..."; or "Based on these results,..."; etc.
8. For example, "To generalize these observations, ..."; "With the aim of elucidating the molecular biology of this phenomenon,..."; etc.
9. There is a lot of confusion about usage of tense in scientific writing, and also some leeway. In general, if you are describing particular experiments that were done in the past (either yours or those of others), use the past tense. "Optimal conditions for cell growth were established"; "The blot was hybridized with nick-translated probe from clone X"; "Smith et al. cloned the receptor gene." By contrast, if you are describing generalizations, or making a statement that had validity and still has validity, use the present tense. "Smith et al. showed that the *fms* oncogene has a protein kinase activity." No matter what convention you use, do not switch between tenses without good reason.
10. There is nothing wrong with saying, "Harris and Jones investigated the relationship....", or "We investigated...", or (for example, in the context of a proposal) "I will investigate..." To the contrary, active voice is much preferable to the passive "The relationship was investigated by Harris and Jones..." In this latter case at least the identity of the actors (H and J) is clear. But if you say, "The relationship was investigated..." (meaning "we" did), the reader may well be confused who did it. Overuse of the passive voice is a common hallmark of poor scientific writing, and is frequently accompanied by this sort of confusion. Get in the habit of using active voice, at least at the start of a paragraph or description, to identify authorship absolutely clearly. Then in continuations of the descriptions, if no ambiguities arise, you may use passive, in order to emphasize the results instead of the authorship.

THESIS DEFENSE (“B”) EXAM

Genetics and Development Graduate Students are expected to produce at least one high quality first-author publication as a condition for obtaining the Ph.D. degree. The oral defense of the Ph.D. thesis (or “B” exam) before the Special Committee occurs after the student has distributed the dissertation to the Special Committee members. (The student must deliver a copy of the thesis to their committee at least one week before the exam.) An open seminar, often scheduled as a Wednesday Field Seminar, is given as close to as possible, if not immediately before, the B-exam.

G&D RESEARCH PAPER AWARD

The Field of G&D awards a yearly prize for the best paper first-authored by a graduate student. This \$500 prize is generously provided by Frank Meleca of Laboratory Product Sales, and is known as the LPS award. An evaluation committee of four faculty members will pick what they judge to be the best G&D paper published during the current calendar year. Please note that

faculty who sponsor students for the award are not eligible to serve on the evaluation committee, which is appointed on an ad hoc basis by the Director of Graduate Studies. All graduate students in the Field who have been first-author on a paper in the current calendar year are eligible, including previous winners and those who have since left Cornell. If two papers are deemed equivalent, and one of the students had won the award previously, then the award will go to the other student.

A G&D faculty mentor or student should submit five copies of their paper to Vicki Shaff (ves3@cornell.edu). Please include with the paper a letter from the mentor outlining both the importance of the paper and the contributions made by the student. The name of the award winner will be announced in May, and will be inscribed on a plaque in the MB&G departmental offices, and a list of all of the student publications for the year will be posted near the plaque.

A notice will be sent in late winter/early spring to both students and faculty calling for applications.

FINANCIAL INFORMATION

TAs, GRAs, FELLOWSHIPS

Students making satisfactory progress in the Field of Genetics and Development receive financial support, including tuition fellowships or waivers. Support beyond five years will be contingent on a review of progress by the DGS and Department Chair in consultation with the major professor and student. In your progress report each Spring semester you will indicate your desired form of financial support for the coming year. Your preferences will be met whenever possible. There are three main sources of financial support: teaching assistantships (TA), graduate research assistantships (GRA), and fellowships. TAs stipulate a time commitment of 15 hours/week (20 hours for some Intro. Biology TAs) and provide a stipend as well as tuition. The Department of Molecular Biology and Genetics is allocated 10 academic year TA positions and these are assigned each semester based on the teaching needs of our instructors and the financial needs of our graduate students. Teaching performance is evaluated by the students in the courses and reviewed by the teaching faculty of the Section. This review becomes a part of the graduate record and is included in consideration for subsequent support.

Funds for GRAs come from several sources including grants awarded to individual faculty members. Support from a faculty research grant must be arranged with the faculty member involved. Fellowships are awarded from the Genetics and Development Training Grant and the Plant Cell and Molecular Biology Training Grant, as well as from the Graduate School.

NIH Training Grant in Genetics and Development: Students who are US citizens or permanent residents are eligible for support by the NIH Training Grant in Genetics and Development. Appointments to the training grant are made competitively for one year periods. Decisions about the training grant are made by a committee composed of the Principal Investigator of the Training Grant, the Director of Graduate Studies, and an elected member of the faculty from the Field. The training grant is used to support students during their first year on a non-competitive basis, and during subsequent years (up to three total) on a competitive basis.

University-Wide and Other Fellowships: Fellowship money is available from Cornell University on a competitive basis for incoming students awarded by their Field (e.g., Sage fellowship, Genomics fellowship and Presidential fellowship).

Predoctoral fellowships (including some reserved for under-represented minority students) are awarded by The National Science Foundation and the National Institutes of Health to students in the early stages of graduate study. Please contact the DGS, GFA, or your faculty advisor to obtain more information about these fellowships.

Other private foundations that offer fellowships are listed in the "Fellowship Notebook", located on the Graduate School web site at <http://www.gradschool.cornell.edu/>.

SUMMER SUPPORT

If your support does not continue through the summer (e.g., TAs), summer support is available from faculty research grants, and Graduate School Summer Assistantships which are awarded by the Department on the basis of need. Discuss your situation with the Administrative Manager and your major professor.

TAX STATUS OF STIPENDS

All stipends awarded (assistantships **and** fellowships) are considered taxable income. State and Federal income tax is withheld from all assistantship paychecks that are processed through Cornell's payroll system (TAs). Fellowships awarded by the Graduate School do not have taxes withheld. However, these awards are taxable and students are responsible for filing a tax return and for paying taxes. Tuition is not considered taxable income unless provided directly for "services rendered." Books and supplies are deductible and receipts should be kept (consult your tax advisor!).

RESEARCH GRANTS

Numerous grants are available for students who take the time and effort to apply for them. Grantsmanship is an important skill in academia and one worth refining early. Some proposals must be submitted in the name of a faculty member, such as those awarded by the National Science Foundation (NSF), the National Institutes of Health (NIH), the US Department of Agriculture (USDA) Competitive Grants Program, the Department of Energy (DOE), the Department of Defense (DOD), the World Health Organization (WHO), and the National Geographic Society. The Office of Sponsored Programs (373 Pine Tree Road, East Hill Plaza, 5-5014) has a Federal Register of weekly listings of available money and has several compendia of agencies and industries that provide research grants. Other research grants are awarded directly to graduate students. Some of the more reliable sources include:

1. Cornell Chapter of Sigma Xi, the Scientific Research Society. This is an especially good source for new graduate students. Awards are in the \$100 to \$300 range. Application deadline is in February.
2. Sigma Xi, National Headquarters (345 Whitney Avenue New Haven, CT 06511). Application deadlines for the Grants-in-Aid Program (\$100 - \$1,000) occur three times a year.
3. American Association of University Women (Director, Programs Office, 2401 Virginia Avenue NW, Washington, DC 20037) offers Grants-in-aid, Dissertation Completion Grants, and Postdoctoral Fellowships for women. These are very competitive — available to women in all fields.
4. Grants for Improving Doctoral Dissertation Research (National Science Foundation, Forms and Publications Unit, 1800 G Street, NW - Room 232, Washington, DC 20550). Funds are available for almost every facet of research except stipends and tuition. Proposals are written by students but submitted on behalf of the student by the major advisor through Cornell's Office of Sponsored Programs. Call the Office of Sponsored Programs (5-5014) for current deadlines.
5. Fulbright grants support graduate study or research abroad. Applications are available in the Fellowship Office, 155 Caldwell. Competitive, but well worth the effort if you plan to study overseas.
6. Congressionally Directed Medical Research Grants. This program funds research for graduate students whose projects focus on a variety of human diseases. Information on the grants can be found at: <http://cdmrp.army.mil/>. Students at Cornell have won these awards!

TRAVEL GRANTS

The **Conference Travel Grant** from the Graduate School provides money for travel to enable full time students to present papers or posters at professional meetings. The maximum award is \$600, but the amount of the award is based on geographic location and will not necessarily cover the full cost of the student's transportation expenses. For specific information and an application, contact the Graduate Field Assistant or the Fellowship Office in Caldwell Hall. Applications must be made by the first day of the month before the month of the conference (see deadlines on application) to allow review by the Graduate Student Screening Committee.

The **Center for International Studies** awards funds for Ph.D. candidates for research-related travel having direct relevance to international or "comparative" studies. Deadline for application is in March.

The **NIH Training Grant in Genetics and Development** provides travel funds. Students supported by the Training Grant are encouraged to use these funds and should discuss their travel plans early with their major professor.

GRADUATE STUDENT ACTIVITIES

An **Annual Picnic** is held each year (late August) and is a good way to meet the students, staff and faculty. The picnic is organized in large part to welcome the incoming class of graduate students. Look for flyers and an announcement at orientation. Rides are provided if needed.

Intramural Sports are a great way to get to know people. There are many sports activities, softball, volleyball and basketball are possibilities, and several students and faculty play ice hockey with graduate student teams. Look for sign-up sheets on bulletin boards around the building and ask your fellow students.

The **Big Red Barn** is a place to eat, socialize and meet other graduate students. You can reserve space there at no cost for professional or social activities. Also, be aware that the Student Life Union at Willard Straight Hall will provide money to student groups who want to sponsor activities involving students.

The **Graduate and Professional Student Assembly** is a major forum for discussion and implementing actions that affect graduate students. Each Field has a student representative on the assembly.

An **Expanding Your Horizons Workshop** is usually held every year on campus. The conference, for girls in the 6th-8th grades, is organized and staffed by women graduate students, postdoctoral, and faculty volunteers. Watch for notices. This activity provides a good way to meet other women in math and science, and to share experiences with others interested in education and teaching. See: http://www.ccmr.cornell.edu/education/eyh/Workshop_Leaders.php.

For a complete list of the graduate student organizations on campus, go to <http://www.sao.cornell.edu/so/> or <http://www.gradschool.cornell.edu/>.

FIELD RESOURCES

CORNELL BIOTECHNOLOGY RESOURCE CENTER

The Cornell Biotechnology Resource Center (BRC) is located on the first floor of the Biotechnology Building. This fee-for-service group has instrumentation and trained personnel for performing a variety of biotechnology analyses:

The **Microscopy and Imaging** facility specializes in confocal and fluorescence microscopy and digital image analysis. Training and consulting are offered and the microscopes are available to trained users 24/7. Systems include a Leica spectral scanning confocal microscope, Metamorph analysis software, a spectrofluorimeter and a stereo microscope with digital camera.

The **DNA Sequencing and Genotyping** laboratory maintains high throughput, automated DNA sequencers and provides full service DNA sequencing of plasmids and PCR products.

Services are also available for microsatellite analysis, SNP genotyping, real-time PCR, and robotic liquid handling using several Tecan robots.

The **Proteomics and Mass Spectrometry** laboratory provides mass spectrometry and proteomics services for the identification and characterization of proteins and peptides, the development of new analytical methods, and consultation and data interpretation in support of proteomic research projects. Instrumentation includes mass spectrometers, HPLC systems, a 2D gel electrophoresis system, robots for gel spot picking and gel digestion, and an imaging system for quantitative fluorescence analysis.

Computing Services offers access to a number of commercial software licenses and supports the Information Technology infrastructure for BRC facilities as well as a number of other units on campus, and are available for ad hoc consulting in information technology or bioinformatics.

KELLER READING ROOM/THESIS COLLECTION/COMPUTER ACCESS

Located on the ground floor of the Biotechnology Building (Room G09), the Elizabeth Keller Reading Room offers a quiet and beautiful setting to read the latest journals. Reference materials and a small number of older journals that cannot be found on line are also located here, as well as the Keller and Blackler collections of classics on the history of biochemistry and genetics. Cornell has an extensive collection of journals that are available online. **Please note that material is not to be taken from this room.** A photocopier is available for your convenience.

Several computers and a printer are available in the Keller Room to access online journals and print class assignments. Accounts that allow use of this facility can be obtained from Rita Stucky (lhs32@cornell.edu). In addition, Red Rover Wireless is available throughout the common areas of the Biotechnology Building.

The Elizabeth Keller Reading Room also contains a collection of theses completed by graduates in the Fields of Genetics and Development and Biochemistry, Molecular and Cell Biology. Full collections are maintained in Mann Library.

CAREERS INFORMATION

A collection of books focused on managing careers in the biological sciences can be found in the main office of the Biotechnology Building (Room 107). Students should feel free to sign these books out.

At the Bench: A Laboratory Navigator by Kathy Barker
At the Helm: A Laboratory Navigator by Kathy Barker
Academic Scientists at Work by J. Boss and S. Eckert
Making the Right Moves, organized by the HHMI and BBWF
Alternative Careers in Science, edited by Cynthia Robbins-Roth
Careers in Biotech and Pharmaceuticals by Wet Feet, Inc.

IMPORTANT PHONE NUMBERS

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Graduate School Forms
Graduate School
143 Caldwell Hall
Telephone: 255-5820
<http://www.gradschool.cornell.edu/?p=11>

Housing Services:

Campus Life Housing Office
119 Robert Purcell Community Center
Telephone: 255-5368
http://campuslife.cornell.edu/graduate_housing/GPSH@cornell.edu

Medical Services:

University Health Service
Gannett Medical Clinic
10 Central Avenue
Telephone: 255-5155 (24 hours, 7 days a week)
<http://www.gannett.cornell.edu/>

Let's Talk:

Problems with stress, academic problems, anxiety, relationships, adjustment to a new culture, family problems, depression, financial difficulties and other concerns. No appointment necessary; walk in at any one of the locations: Olin, Carol Tatkon Center, Rockefeller, Caldwell (ISSO), Myron Taylor, Sage, Goldwin Smith, Ujamaa, CCC and more. Telephone: 255-5208; www.gannett.cornell.edu/CAPS/offsiteSupport.html.

Employment for Spouses:

Office of Human Resources
<http://www.ohr.cornell.edu/OHRWEB-L@cornell.edu>

HISTORY OF GENETICS AND DEVELOPMENT AT CORNELL UNIVERSITY

by Adrian Srb, 1985 & 1991; Antonie Blackler, 1997

When the Division of Biological Sciences was created at Cornell in 1964 as one of the recommendations of the Morison Commission -- an extramural group appointed by President Perkins to examine the organization of basic biology at the University, genetics and development as areas of research and teaching became the responsibility of the newly created Section of Genetics, Development & Physiology -- a hybrid collection of faculty drawn from three departments in the Endowed and Statutory Colleges. The new Division was headed by Robert A. Morison, the Chairman of the Commission whose influence is still manifest in much of the Division's structure and activities.

The geneticists of the new Section were drawn, for the most part, from the Department of Plant Breeding. This department had a distinguished history that could be traced back to the era of Rollins A. Emerson and his "school" of maize geneticists of the 1920s and '30s. Emerson's group carried out research that established maize as one of the best known 'genetic' organisms and worked out many extensions of Mendelian principles. Some of Emerson's students and others associated with his group went on to be the most influential geneticists of their generation -- the Nobel laureates George W. Beadle and Barbara McClintock, and the distinguished geneticists Milislav Demerec, Marcus Rhoades, George Sprague, Charles Burnham, and E.G. Anderson¹.

In 1964 the geneticists of the new Section were Bruce Wallace, a population geneticist who did his experimental work with *Drosophila*; Harry Stinson, an *Oenothera* geneticist; and Adrian Srb, a fungal geneticist working primarily with *Neurospora*. The need for strength in the biochemical aspects of genetics was met by a new faculty appointment, Ross MacIntyre, who used biochemical genetic approaches to evolutionary and developmental problems in *Drosophila*.

The developmental faculty was drawn from the former Department of Zoology, the history of which could be traced back to the time of Burt G. Wilder, a neuroanatomist whose collection of human brains still forms part of the University archives. In 1964, the Department of Zoology was emerging from some internal divisiveness. The four Zoology faculty attached to the new Section were William Wimsatt, known for his work on the reproduction of bats; John Anderson, whose laboratory researched the regenerative properties of echinoderms; Samuel Leonard, closing a long career in the isolation and characterization of reproductive hormones; and Antonie Blackler, a developmental biologist whose studies of embryonic germ line cells in amphibia had genetic implications. Blackler had just arrived from Switzerland as the last appointment in the Department of Zoology.

The remaining faculty were drawn from the Department of Botany. Among them was Charles Uhl, a plant cytogeneticist whose research interests focused on cytotaxonomic problems in succulent plants; and Harlan Banks, a paleobotanist. The 'physiology' of the new Section's title really meant plant physiology, and a coherent faculty nucleus was created from old and new appointments, among which may be noted those of André Jagendorf, Roderick Clayton, Dominick Paolillo, and Peter Davies.

Even with this considerable mustering of strength in genetic and developmental research, Section members saw gaps, particularly in molecular aspects of genetics that needed to be filled if the University were to have a thoroughly modern array of research programs. A request for two new positions was considered favorably. As a result there were appointed Gerald Fink, a molecular geneticist using yeast as an experimental object; and Peter Bruns, a geneticist working with the ciliate *Tetrahymena*. An additional appointment of Richard Hallberg was made in the

area of developmental biology to create a focal point for training and research in molecular aspects of development, and an electron microscopist, Mandayam Parthasarathy, was also added to the faculty. Hallberg, whose work with the frog *Xenopus* principally concerned the role of ribosomal proteins, subsequently left for a position at Iowa State University.

During the 1970s, much of the genetic and developmental research ascribable to the Section, later to be called the Section of Genetics and Development with the departure of the plant-oriented faculty to a new Section of Plant Biology, can be described in reference to the professorial staff assembled as noted in the preceding paragraphs. The details cannot possibly be dealt with in this brief space, but important general features include the following:

Wallace continued his status as one of the world's best population geneticists, in part by writing a series of books and monographs treating various aspects of his field in highly innovative ways. Experimentally, he demonstrated the heterotic effects of deleterious mutations induced by irradiation in *Drosophila* populations, and also used original approaches to examine a series of questions in ecological genetics.

MacIntyre and his group succeeded in the isolation and characterization of mutations affecting enzymes having important metabolic functions. Analysis of the *Drosophila* enzyme mutants gave insight into the puzzling classical genetic phenomenon known as position effect variegation. Some of the mutants gave opportunities for studies of the genetic control of behavioral responses.

Before leaving the University for the Whitehead Institute at MIT, the Fink group carried out molecular genetic studies of yeast that yielded better understanding of mutation and recombination, capped by the demonstration of genetic transformation in yeast -- the first such in a eukaryote and very important for subsequent progress in the molecular biology of higher organisms.

Bruns invented techniques that permitted him to establish *Tetrahymena* as a useful and attractive organism for genetic research, and to explore the potential of the ciliate as a model developmental system.

In Srb's laboratory cytoplasmic inheritance was extensively studied in *Neurospora*, with mitochondrial systems being shown to have substantial autonomy in reference to chromosomal influence. Other work utilized mutants in an analysis of the sexual reproductive process operating in fungi and the developmental sequence of ascospore maturation.

Until assuming full-time administrative duties in the Division, Stinson conducted intriguing studies of plastid genetics in *Oenothera*. In the absence of a regular diploid system, Blackler used interspecific hybrids of *Xenopus* to study the expression of nucleolar and various enzyme patterns. Wimsatt became involved in the reproductive and economic biology of vampire bats and edited a three volume treatise of bat biology. Uhl defined numerous karyotypes in taxonomically related succulent plants while elaborating their systematic and ecological relationships.

Further reorganization of the biological sciences at Cornell provided additional strength to the Section of Genetics and Development and at the same time filled a significant gap in its research programs. Stanley Zahler was transferred into the Section from the Department of Microbiology. Until Zahler's arrival prokaryote genetics had no representation in the group designated as having primary responsibility for genetics. After earlier work with myxobacteria, Zahler had a major influence in establishing *Bacillus subtilis* as an effective object of genetic analysis. His isolation of appropriate transducing phages provided a potent tool for a refined analysis of the *B. subtilis* genome. On his retirement in 1994, active recruiting for a replacement was successful in bringing a yeast geneticist to the Section -- Eric Alani, whose laboratory group is studying mismatch repair mechanisms in yeast chromosomes. By the addition of Valley

Stewart of the Section of Microbiology as a Joint Appointee in Genetics & Development, the bacterial genetics lacuna later caused by the Zahler retirement was covered. Stewart's research is directed to the genetic regulation of nitrate metabolism in gram-negative bacteria.

With the arrival of the 1980s, the Section, to replace Gerald Fink, appointed Thomas D. Fox who, like Fink and Alani, is a specialist in the molecular genetics of yeast. Fox focuses on the regulation of mitochondrial genes at the translational level.

The restructuring within the Division of Biological Sciences that ultimately created the Section of Plant Biology, as noted above, put the genetics and development faculty in a favorable position to reevaluate the mission of the Section of Genetics and Development (as it became now known). It was concluded that Cornell was underrepresented in developmental biology; hence a case was made for new appointments of developmentalists whose research would be firmly based in genetic thinking and approach. The result was that the Section hired three young biologists who might equally well be called geneticists or developmentalists but whose problem areas for research were clearly developmental in character. The emphasis was, and still is, on the genetic underpinnings of development. These appointees were: Michael Goldberg, who investigates the molecular and genetic bases of mitosis in *Drosophila*; Mariana Wolfner, who studies sexual differentiation and fertility in *Drosophila* by isolating, and defining molecular sequences that are transcribed at particular stages; and Kenneth Kemphues, who uses mutants in analyzing critical cytoplasmic steps in the very early development of the nematode *Caenorhabditis elegans*.

With the departure of Wallace in 1981 to the State University of Virginia, and the untimely death of Wimsatt thereafter, three more appointments were made to fill major lacunae in the representation of genetic research. Maureen Hanson joined the Section in 1985 to represent and develop the relatively new area of the molecular genetics of plants. She also has a significant research involvement in the mitochondrial genetics of higher plants, notably *Petunia*. Charles Aquadro, joining the Section in 1985, is a *Drosophila* geneticist who is a leader in the area of molecular population genetics. His group is involved in quantitative studies of the extent of genetic variation in natural populations of *Drosophila*. Willie Mark represented mammalian developmental genetics after joining Section in 1988; his laboratory examined insertional mutagenesis in mice (he left the Section in 1995).

Extra strength was added when Rob Last of the Boyce Thompson Institute for Plant Research joined the Section in 1990 as Adjunct Professor. His laboratory represented genetic and molecular approaches to understanding plant growth and reaction to environmental stresses.

Over the years, present and past geneticists from the Section received many honors and awards that recognize research excellence. For example, Srb, Wallace, and Fink are members of the National Academy of Sciences. Bruns, MacIntyre, and Srb have been awarded Guggenheim Fellowships. Wallace and Srb received Fulbright awards. Fox was the recipient of an NIH Research Career Development Award and Wolfner was the recipient of an NSF Career Advancement Award. Wolfner also was awarded an American Cancer Society Faculty Research Award. Hanson received a McKnight Foundation Individual Research Award and is the Liberty Hyde Bailey Professor of Plant Molecular Biology. Last received a National Science Foundation 1990 Presidential Young Investigator Award. Blackler served as a National Science Foundation Division Director in 1980 & 1981.

¹ See *A Feeling for the Organism, The Life and Work of Barbara McClintock* by E.F. Keller, 1983. (Freeman, NY).

EMERGENCY NUMBERS

<u>Problem</u>	<u>Resource</u>
EMERGENCY	
Fire, Police, Ambulance	911
Non Emergency	
Public Safety, Security	5-1111
Building Emergencies	
Dick Clark, Building Coordinator	4-4583
Medical Problems	
Gannett Clinic	5-5155
Chemical Questions	
Environmental Health and Safety	5-8200
Respiratory Protection	
Radiation Spills or Problems	
Right-to-Know (Toxic substances)	
Toxic Waste Disposal Problems	