

# Genetics (BGE)

**Graduate Program Director:** Gerald Thomsen, Centers for Molecular Medicine, Room 348 (631) 632-8536

**Graduate Program Coordinator:** Kathryn Bell, Life Sciences Building, Room 130 (631) 632-8812

**Degree awarded:** Ph.D. in Genetics

The Graduate Program in Genetics, an inter-institutional curriculum in the College of Arts and Sciences, is designed to provide training in a broad area of genetics. It offers graduate training in developmental genetics, evolutionary genetics, genomics and bioinformatics, human genetics, and molecular genetics. All students, no matter what their particular interest, are exposed to all areas of specialization offered within the curriculum. This experience ensures that the student will be prepared to take maximum advantage of the broad range of challenges that may be encountered after graduation. The breadth of the Graduate Program in Genetics makes it likely that the entering predoctoral trainees will come from many varied backgrounds. This enriches the Genetics Program as a whole and enhances student peer interactions.

The first-year student experience includes laboratory rotations during which the student works in the laboratories of three or four different faculty members. These rotations allow the student to gain firsthand knowledge of the methods and approaches taken by each laboratory and provide a basis for selecting a thesis research advisor. Students are expected to join a laboratory within their first year.

Students have the opportunity to further broaden their knowledge by participating in journal clubs on thematic topics that are offered by faculty, and by taking elective courses from offerings both within and outside the Genetics Program. The specific elective course or courses taken by a student are determined in conjunction with a faculty advisor to best meet the student's particular needs. Trainees participate in two ongoing research seminar series. A student research seminar provides each trainee with a regular opportunity to present his or her work to colleagues and to faculty. Students also attend research seminars given by internal and visiting faculty to keep abreast of the latest developments and potential areas of future excitement in the field of genetics.

## Facilities

The primary training facilities are Stony Brook University, Cold Spring Harbor Laboratory, and Brookhaven National Laboratory. Program faculty at Stony Brook are drawn primarily from departments within the College of Arts and Sciences or the School of Medicine. The Life Sciences Building, which houses the Genetics Program office, is home to the Departments of Biochemistry and Cell Biology, Ecology and Evolution, Molecular Genetics and Microbiology, and Neurobiology and Behavior, all of which are represented in the Genetics Program. The Health Sciences Center, located across the street from the Life Sciences Building, is the primary home for departments in the School of Medicine, including faculty in the Departments of Medicine, Molecular Pathology and Immunology, Pharmacological Sciences, and Physiology and Biophysics. In addition to these departments, the program also includes faculty in the Departments of Applied Mathematics and Statistics, Biomedical Engineering, and Computer Science. An important new facility at Stony Brook is the Centers for Molecular Medicine, a state-of-the-art research building adjacent to the Life Sciences Building. This building houses four interdepartmental thematic research centers: The Centers for Brain and Spinal Cord Research, Developmental Genetics, Infectious Diseases, and Structural Biology. Each of these centers harbors Genetics Program faculty. The Centers for Molecular Medicine provide both an intellectual and a physical catalyst for facilitating interactions between Stony Brook scientists with common interest in these areas of modern biology, irrespective of their departmental affiliation.

Cold Spring Harbor Laboratory is a modern, world-renowned research institute that provides numerous unique opportunities for trainees. Although the faculty at Cold Spring Harbor are not organized into departments, there is internationally recognized strength in the areas of Bioinformatics, Cancer Biology, Neurobiology, Plant Genetics,

and Structural Biology. The world-class facilities that are available at Brookhaven National Laboratory provide additional unique resources for trainees in the Genetics Program, including the National Synchrotron Light Source, one of the most unique instruments in the world for probing biological phenomenon. Research faculty at Brookhaven have widely recognized programs in the molecular biology of microbial, plant, and animal systems, and have a leading role in the emerging field of proteomics.

## Admission

The Graduate Program in Genetics requires the following in addition to the minimum Graduate School admission requirements:

A. Superior undergraduate performance, which should include some formal training in genetics;

B. Report of Graduate Record Examination (GRE) General Test scores. Note that subject-specific tests (i.e., biology) are not required, but are helpful additional information when available;

C. Three letters of recommendation;

D. Acceptance by the Graduate Program in Genetics and by the Graduate School.

The program does not require, but prefers to see, evidence of research activity as an undergraduate. Whenever possible, prospective students are encouraged to visit for interviews with program faculty.

All students who are accepted into the program are accepted with full support. The support package for the 2008-2009 academic year includes an annual stipend of \$26,000, a tuition scholarship, and health insurance benefits. Students who remain in good standing with both the Genetics Program and the Graduate School receive tuition scholarships, health insurance benefits, and stipend support throughout their graduate careers.

## Faculty

### Distinguished Professors

Grollman, Arthur,<sup>6</sup> M.D., Johns Hopkins University: Mechanisms of DNA repair and mutagenesis in mammalian cells.

Lennarz, William J.,<sup>2</sup> Ph.D., 1959, University of Illinois: Biosynthesis and function of cell surface glycoproteins.

Rubin, Clinton,<sup>9</sup> Ph.D., 1983, Bristol University: Physical factors influencing bone, cell, and tissue kinetics; treatments.

Sternglanz, Rolf,<sup>2</sup> Ph.D., 1967, Harvard University: Yeast molecular genetics.

Wimmer, Eckard,<sup>3</sup> Dr.rer.nat., 1962, Gottingen, Germany: Poliovirus replication and picornaviral pathogenesis.

### Professors

Bahou, Wadie,<sup>5</sup> M.D., 1980, Massachusetts Medical Center: Human genetics; gene therapy.

Bell, Michael,<sup>4</sup> Ph.D., 1976, University of California, Los Angeles: Evolutionary genetics.

Benach, Jorge,<sup>3</sup> Ph.D., 1971, Rutgers University: Infectious disease immunology.

Bliska, James B.,<sup>3</sup> Ph.D., 1988, University of California, Berkeley: Molecular and cellular basis of bacterial-host cell interactions.

Bogenhagen, Daniel,<sup>6</sup> M.D., 1977, Stanford University: Molecular biology of oocyte development.

Brown, Deborah,<sup>2</sup> Ph.D., 1987, Stanford University: Structure and function of sphingolipid and cholesterol-rich membrane domains.

Carter, Carol A.,<sup>3</sup> Ph.D., 1972, Yale University: Retroviral viral assembly and post-assembly events.

Chen, Wen-Tien,<sup>5</sup> Ph.D., 1979, Yale University: Cancer invasion and angiogenesis.

Citovsky, Vitaly,<sup>2</sup> Ph.D., 1987, Hebrew University, Jerusalem: Nuclear transport and intercellular communication in plants.

Deutsch, Dale G., Ph.D., 1972, Purdue University: Molecular neurobiology of anandamide 2-AG (endogenous marijuana).

Eanes, Walter,<sup>4</sup> Ph.D., 1976, Stony Brook University: Genetic variation in natural populations.

Frohman, Michael,<sup>6</sup> M.D., Ph.D., 1985, University of Pennsylvania: Early mammalian development.

Furie, Martha B.,<sup>8</sup> Ph.D., 1980, Rockefeller University: Molecular basis of cell-cell and cell-substrate interactions.

Futcher, A. Bruce,<sup>3</sup> D.Phil., 1981, University of Oxford: Control of cell division in eukaryotic cells.

Gergen, J. Peter,<sup>2</sup> Ph.D., 1982, Brandeis University: Regulation of transcription and the genetic control of development.

Ghebrehiwet, Berhane,<sup>5</sup> D.V.M./D.Sc., 1974, University of Paris, France: Biochemistry; role of complement C1q receptors during infection and inflammation.

Hearing, Patrick,<sup>3</sup> Ph.D., 1980, Northwestern University: Adenovirus regulation of cellular

proliferation and gene expression; vectors for human gene therapy.

Konopka, James,<sup>3</sup> Ph.D., 1985, University of California, Los Angeles: Cell growth and development in yeast; pheromone signal transduction.

Malbon, Craig,<sup>6</sup> Ph.D., 1976, Case Western Reserve University: Signal transduction and gene regulation in differentiation and development.

Marcu, Kenneth B.,<sup>2</sup> Ph.D., 1975, Stony Brook University: Immunoglobulin gene expression and recombination.

Moll, Ute,<sup>8</sup> M.D., 1985, University of Ulm: Tumor suppressor genes; role of p53 in human cancer.

Reich, Nancy,<sup>8</sup> Ph.D., 1983, Stony Brook University: Signal transduction and activation of gene expression by cytokines; cellular defense responses to viral infection.

Reinitz, John,<sup>11</sup> Ph.D., 1988, Yale University: Computational biology; modeling of gene regulatory networks.

Smith, Steven,<sup>2</sup> Ph.D., 1985, University of California, Berkeley: Structural biology.

### Associate Professors

Bharathan, R. Geeta,<sup>4</sup> Ph.D., 1993, University of Arizona: Plant development and evolution.

Bingham, Paul,<sup>2</sup> Ph.D., 1979, Harvard University: Regulation of differentiation; transposable elements; regulation of splicing.

Dean, Neta,<sup>2</sup> Ph.D., 1988, University of California, Los Angeles: Protein trafficking in yeast.

Hadjiargyrou, Michael,<sup>9</sup> Ph.D., 1992, City University of New York: Human molecular genetics; functional genomics.

Hatchwell, Eli,<sup>5</sup> M.D., 1985, University of Cambridge; Ph.D., 1995, University of Oxford: Sporadic human genetic disease.

Holdener, Bernadette,<sup>2</sup> Ph.D., 1990, University of Illinois: Genetics of mammalian development.

Kernan, Maurice,<sup>1</sup> Ph.D., 1990, University of Wisconsin: Molecular basis of mechanical senses.

Leatherwood, Janet,<sup>3</sup> Ph.D., 1993, Johns Hopkins University: Cell cycle control of DNA replication.

Mackow, Erich,<sup>5</sup> Ph.D., Temple University: Rotavirus and hantavirus pathogenesis; virus directed cell signaling and transcriptional responses.

Neiman, Aaron,<sup>2</sup> Ph.D., 1994, University of California, San Francisco: Developmental regulation of the secretory pathway.

Thanassi, David,<sup>3</sup> Ph.D., 1995, University of California, Berkeley: Biogenesis of bacterial adhesion organelles.

Thomsen, Gerald,<sup>2</sup> Graduate Program Director, Ph.D., 1988, Rockefeller University: Vertebrate embryo development.

Tsirka, Stella,<sup>6</sup> Ph.D., 1989, Aristotelian University of Thessaloniki, Greece: Tissue plasminogen activator in the mammalian hippocampus; neuronal-microglial interactions.

White, Thomas,<sup>12</sup> Ph.D., 1994, Harvard Medical School: Gap junction functions defined by genetic diseases and gene knockouts.

### Assistant Professors

Canli, Turhan,<sup>13</sup> Ph.D., 1993, Yale University: Biopsychology; neural and genetic basis of emotion and cognition.

Carpino, Nicholas,<sup>3</sup> Ph.D., 1997, Stony Brook University: Positive and negative regulation of T cell receptor signaling.

Cohen, J. Craig,<sup>14</sup> Ph.D., 1976, University of Mississippi Medical Center: Molecular genetics and physiology; gene therapy.

Colognato, Holly,<sup>6</sup> Ph.D., 1999, Rutgers University: Extracellular matrix in the brain; roles during development and during neurodegeneration.

Crawford, Howard,<sup>6</sup> Ph.D., 1993, University of Texas Southwestern Medical Center at Dallas: Pancreatic cancer.

Hsieh, Jen-Chih,<sup>2</sup> Ph.D., 1994, Duke University: The molecular mechanism of Wnt signaling.

Karzai, Wali,<sup>2</sup> Ph.D., 1995, Johns Hopkins University: Structure and function of RNA-binding proteins and biochemical studies of the SmpB-SsrA quality control system.

Lee, Christopher S. D.,<sup>3</sup> M.D., 1996, University of Medicine and Dentistry of New Jersey: Urologic oncology, tumor immunology.

Maletic-Savatic, Mirjana,<sup>1</sup> M.D., 1985, Ph.D., 1996, University of Belgrade, Yugoslavia: Neural stem cell differentiation.

Sirotkin, Howard,<sup>1</sup> Ph.D., 1996, Albert Einstein: Specification and patterning of the neural plate; vertebrate developmental genetics.

Takemaru, Ken-Ichi,<sup>6</sup> Ph.D., Graduate University for Advanced Studies, Japan: Wnt signaling in development and disease.

True, John R.,<sup>4</sup> Ph.D., 1995, Duke University: Drosophila melanin patterning; developmental genetics and natural selection.

Zong, Wei-Xing,<sup>3</sup> Ph.D., 1999, UMDNJ-Robert Wood Johnson Medical School: Molecular regulation of apoptotic and necrotic cell death.

### Adjunct Faculty at Cold Spring Harbor Lab

Cline, Hollis, *Professor*, Ph.D., 1985, University of California, Berkeley: Neuronal development and plasticity.

Dubnau, Josh, *Assistant Professor*, Ph.D., 1995, Columbia University: Learning; memory; genetics; behavior.

Enikolopov, Grigori, *Associate Professor*, Ph.D., 1978, U.S.S.R. Academy of Sciences: Signal transduction in neurons.

Hannon, Greg, *Professor*, Ph.D., 1992, Case Western Reserve University: Growth control in mammalian cells.

Hirano, Tatsuya, *Professor*, Ph.D., 1989, Kyoto, Japan: Higher order chromosome structure and function.

Huang, Z. Josh, *Associate Professor*, Ph.D., 1994, Brandeis University: Neuroscience;

experience-dependent development of the neocortex; mouse genetics; neurotrophins.

Jackson, David, *Professor*, Ph.D., 1991, East Anglia, England: Plant development; genetics, cell-to-cell mRNA, and protein trafficking.

Joshua-Tor, Leemor, *Professor*, Ph.D., 1990, Weizmann: Structural biology and molecular recognition.

Krainer, Adrian R., *Professor*, Ph.D., 1986, Harvard University: Mammalian mRNA splicing; regulation of alternative splicing; biochemistry of spliceosome assembly and RNA cleavage-ligation; origin and evolution of introns.

Lazebnik, Yuri, *Professor*, Ph.D., 1986, St. Petersburg State University: Apoptosis; caspases; cancer chemotherapy; proteases.

Lowe, Scott, *Professor*, Ph.D., 1994, Massachusetts Institute of Technology: Apoptosis; anti-cancer therapy resistance.

Martienssen, Robert, *Professor*, Ph.D., 1986, University of Cambridge: Plant developmental genetics; transposable elements; chloroplast biogenesis.

McCombie, Richard, *Professor*, Ph.D., 1982, University of Michigan: Computational molecular biology.

Mills, Alea, *Professor*, Ph.D., 1997, University of California, Irvine: Functional genomics; tumorigenesis; development.

Mittal, Vivek, *Assistant Professor*, Ph.D., 1994, Jawaharlal Nehru University: Tumor-mediated neovascularization; Id transcription factors; transcription profiling; RNA interference; dendritic cells.

Muthuswamy, Senthil, *Associate Professor*, Ph.D., 1995, McMaster University: Understanding cancer initiation using 3-D epithelial structures.

Powers, Scott, *Associate Professor*, Ph.D., 1983, Columbia University: Cancer gene discovery; cancer diagnostics and therapeutics; cancer biology.

Sebat, Jonathan, *Assistant Professor*, Ph.D., 2002, University of Idaho: Copy number variation; segmental duplication; genetics; neurogenetics; ROMA; microarray.

Skowronski, Jacek, *Associate Professor*, M.D., Ph.D., 1981, Lodz, Poland: HIV genes and signal transduction in T cells.

Spector, David, *Professor*, Ph.D., 1980, Rutgers University: Functional organization of the mammalian cell nucleus.

Stenlund, Arne, *Associate Professor*, Ph.D., 1984, Uppsala, Sweden: DNA replication of bovine papillomas.

Stillman, Bruce, *Professor*, Ph.D., 1979, Australian National: Eukaryotic DNA replication and its control.

Tansey, William, *Professor*, Ph.D., 1991, University of Sydney: Cell cycle; gene regulation.

Timmermans, Marja, *Associate Professor*, Ph.D., 1996, Rutgers University: Plant development.

VanAelst, Linda, *Professor*, Ph.D., 1991,

Leuven, Belgium: Role of Ras in mammalian cell transformation.

Wigler, Michael H., *Professor*, Ph.D., 1978, Columbia University: Signal transduction and growth control in eukaryotes.

Zhang, Michael, *Professor*, Ph.D., 1987, Rutgers University: Computational biology and genome informatics.

Zhong, Yi, *Professor*, Ph.D., 1991, University of Iowa: Neurophysiology; drosophila; learning and memory; neurofibromatosis; signal transduction.

### Research Faculty at Brookhaven National Laboratory

Anderson, Carl W., *Senior Geneticist*, Ph.D., 1970, Washington University: Molecular biology of adenovirus assembly; protein synthesis.

Dunn, John J., *Senior Microbiologist*, Ph.D., 1970, Rutgers University: Transcription, processing, and translation of RNA.

Freimuth, Paul, *Scientist*, Ph.D., 1986, Columbia University: Mechanism of adenovirus entry into cells; role of cell adhesion molecules.

Fu, Dax, *Biochemist*, Ph.D., 1996, Mayo Graduate School of Medicine: Structures of representative channel and transporter proteins.

*Number of teaching, graduate, and research assistants, Fall 2007: 59*

- 1) Department of Neurobiology and Behavior
- 2) Department of Biochemistry and Cell Biology
- 3) Department of Molecular Genetics and Microbiology
- 4) Department of Ecology and Evolution
- 5) Department of Medicine
- 6) Department of Pharmacological Sciences
- 7) Department of Oral Biology and Pathology
- 8) Department of Pathology
- 9) Department of Orthopaedics
- 10) Department of Computer Sciences
- 11) Department of Applied Mathematics and Statistics
- 12) Department of Biophysics and Physiology
- 13) Department of Psychology
- 14) Department of Pediatrics, Neonatology

## Degree Requirements

### Requirements for the M.A. Degree

The Graduate Program in Genetics normally does not accept a student whose goal is a master's degree. In exceptional instances, a student already in the graduate program may be awarded an M.A. degree upon completing an approved course of study, including a minimum of 30 graduate credit hours, passing a comprehensive examination, presenting and defending a research thesis, and fulfilling the minimum requirements of the Graduate School. A student must achieve an overall 3.0 grade point average in all graduate course taken at Stony Brook to receive a degree.

## Requirements for the Ph.D. Degree

In addition to the requirements of the Graduate School, the following are required:

### A. Course Requirements

1. HBM 503/BMO 503/MCB 503 Molecular Genetics
2. BGE 510 Graduate Genetics
3. MCB 520 Graduate Biochemistry
4. MCB 656 Cell Biology
5. BGE 531 Graduate Student Seminar in Genetics must be taken each semester.
6. Three semesters of BGE 691 Journal Club typically taken during the first and second years of study. Students select from thematic journal club topics that are organized each semester by faculty at the different institutions. This exercise provides important training in critical analysis of the literature while also allowing students to broaden their knowledge base on selected topics of interest.
7. An elective course approved by the program director. Typically these courses are in the Biological Sciences (e.g., MCB 657 Developmental Biology; HBP 533 Immunology; HBM 640 Microbiology; or BEE 565 Molecular Evolution), but courses may also be taken in other relevant areas (e.g., Computer Sciences, Bioengineering).
8. Two semesters of BGE 530 Laboratory Rotation in Genetics. Students will generally work in the laboratories of three or four different faculty members during the first year. The particular laboratories are determined by students based on their interactions with individual faculty and must be approved by the graduate program director.
9. GRD 500 Integrity in Science. This required one-semester course on ethics is typically taken in the spring semester of the student's first year.
10. Requirements for any specific student, in addition to those enumerated above, that will be beneficial due to a student's prior training and/or area of specialization will be determined by the program director and executive committee in conjunction with the student and appropriate advisory committee.

**B. Comprehensive (Preliminary) Examination**

At the beginning of the fourth semester, students will take a written comprehensive (preliminary) examination covering all areas of genetics.

**C. Thesis Proposal Examination**

After successful completion of the comprehensive (preliminary) examination, the student prepares a written proposal for the thesis research project. This proposal has a format of a grant application, including information of the background and significance of the project, a detailed research plan, and any preliminary results that the student has generated that indicate the feasibility of the project. This written proposal is orally defended before a thesis proposal examination committee. This committee does not include the student's thesis advisor, but is selected by the student in conjunction with his or her advisor and program director. The thesis proposal defense should occur during the fifth semester of graduate study. Generally, the faculty who participate in a student's thesis proposal examination committee then join with the thesis advisor to form the student's thesis advisory committee.

**D. Advancement to Candidacy**

After successful completion of all required and elective courses, the comprehensive (preliminary) examination, and the thesis proposal examination, the student will be recommended to the Graduate School for advancement to candidacy.

**E. Ph.D. Dissertation**

The research for the Ph.D. dissertation is conducted under the supervision of the thesis advisory committee. Upon approval of the completed dissertation by this committee, a formal public oral defense of the dissertation is scheduled, at which the student presents his or her findings and is questioned by members of the examining committee and by other members of the audience.

**F. Teaching Requirement**

It is expected that each graduate student completing a doctoral degree will have functioned as a teaching assistant during at least two semesters of his or her graduate career (BIO 600).

**G. Residence Requirement**

The University requires at least two

consecutive semesters of full-time graduate study. The demands of the course of study necessitate a longer period of residence.

**Courses****BGE 510 Graduate Genetics**

This course investigates fundamental aspects of the transmission and expression of genetic information in prokaryotic and eukaryotic systems. The course is organized in a way that allows the students to appreciate the breadth of genetics research, while also gaining an in-depth understanding of selected important topics. Students explore the use of both classical and molecular genetic approaches to understand biological processes in genetics model systems including yeast, flies, worms, mouse, and man.

*Spring, 3 credits, ABCF grading*

**BGE 530 Laboratory Rotation**

The student rotates through laboratories of four different genetics program faculty members during the first year. The selection of the laboratories is made by the student, in conjunction with individual faculty, and with the approval of the program director. By taking part in ongoing projects, the student will learn experimental procedures and techniques and become acquainted with research opportunities in the participating programs.

*Prerequisite: Permission of instructor*

*Fall and spring, 1-8 credits, S/U grading*  
*May be repeated once for up to eight credits*

**BGE 531 Graduate Student Seminar in Genetics**

Students have the opportunity to present their research to other students and faculty on an annual basis. Students in the first or second year will present brief seminars as part of a one-day symposium with all of their classmates. Advanced students present research seminars as part of a weekly research seminar series that is attended by faculty and students. Although the first- and second-year students do not present in this weekly seminar series, they should attend these seminars as it provides an excellent mechanism for learning about current areas of research interest.

*Fall and spring, 0-1 credits, S/U grading*  
*May be repeated for credit*

**BGE 550 Genetics Outside Seminar**

Outside seminars and special topics courses in areas relating to genetic studies.

*1-4 credits, ABCF grading*  
*May be repeated for credit*

**BGE 599 Graduate Research**

Original investigation undertaken with the supervision of a member of the program.

*Fall and spring, 1-9 credits, S/U grading*  
*May be repeated for credit*

**BGE 691 Readings in Genetics**

Journal Club on thematic topics in different areas of current genetics research.

*Prerequisite: Permission of instructor*

*Fall and spring, 1 credit, ABCF grading*

*May be repeated for credit*

**BGE 699 Dissertation Research On Campus**

*Prerequisite: Advancement to candidacy (G5); major portion of research must take place on SB campus, at Cold Spring Harbor, or at Brookhaven National Lab*

*Fall, spring, and summer, 1-9 credits, S/U grading*

*May be repeated for credit*

**BGE 700 Dissertation Research Off Campus—Domestic**

*Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place off campus, but in the U.S. and/or U.S. provinces (Brookhaven National Lab and the Cold Spring Harbor Lab are considered on campus); all international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor*

*Fall, spring, and summer, 1-9 credits, S/U grading*

*May be repeated for credit*

**BGE 701 Dissertation Research Off Campus—International**

*Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place outside the U.S. and/or U.S. provinces; domestic students have the option of the health plan and may also enroll in MEDEX; international students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed; international students who are not in their home country are charged for the mandatory health insurance (if they are to be covered by another insurance plan, they must file a waiver by the second week of classes; the charge will only be removed if the other plan is deemed comparable); all international students must receive clearance from an International Advisor*

*Fall, spring, and summer, 1-9 credits, S/U grading*

*May be repeated for credit*

**BGE 800 Summer Research**

*0 credit, S/U grading*

*May be repeated for credit*