

Doctor of Philosophy (PhD) in Bioenergetics

Department of Exercise and Sport Science East Carolina University

DESCRIPTION OF THE PROGRAM

Bioenergetics is the science of energy transposition under varying metabolic conditions. Metabolic conditions which will be studied in the proposed program will include rest, differing intensities of exercise and work, and pathological states such as obesity, diabetes, and other diseases. The essence of bioenergetics is to determine how energy produced and released by the metabolic process is harnessed to perform the cellular work and activities necessary to sustain the life process.¹ Bioenergetics thus ultimately seeks to link cellular or molecular events to how an organism survives in a given environment. The field of bioenergetics is therefore inherently interdisciplinary and incorporates many of the basic science areas. Some of the best examples of bioenergetics research are studies detailing the linkage between metabolism and mechanical events leading to muscle contraction and movement. Findings from these studies led to such notable advancements such as the sliding filament theory of muscle contraction², which is presented in virtually every biology class at high school to university levels. Such inherent broad implications emphasize the importance of the bioenergetics field and its interdisciplinary approach.

Each student will receive unique interdisciplinary training integrating exercise physiology, basic physiology, and biochemistry. The goal of the training is to enable graduates to address research questions at the level of the whole body to the gene using a variety of research approaches. Some relevant research areas in the proposed bioenergetics program will include the mechanistic linkage between energy intake, post-prandial metabolism, and responses to physical activity in terms of energy production and utilization when dealing with the metabolic stresses of disease, inactivity, and aging. Graduates from the program would be employed in health care, government, academic, research and service institutions such as the [Human Performance Laboratory](#), and private institutions with the aim to investigate and promote the role of a physically active lifestyle in disease prevention, intervention, and treatment.

1. The Vital Force: A Study of Bioenergetics, Franklin M. Harold, pgs. IX-XI, 1986.
2. Nobel Laureate A.F. Huxley and H.E. Huxley, series of studies between 1956 and 1969.

PROGRAM JUSTIFICATION

Despite inroads against disease, this nation continues to be burdened by preventable illness. In 1960 the share of the gross domestic product (GDP) directly consumed by

medical services was 5 percent; by 1995 this nearly tripled to approximately 14 percent. When expenses associated with diseases such as cancer, obesity, osteoporosis, diabetes, hypertension and other illnesses are added, total annual health care expenditures are approximately \$1 trillion. The morbidity and mortality associated with cardiovascular disease alone accounted for over \$259 billion in 1997. A relatively controllable disease such as diabetes afflicted nearly 16 million individuals with an associated cost of \$91.1 billion; in contrast, AIDS and breast cancer combined afflicted 3.4 million citizens at an estimated cost of \$16.9 billion. Fortunately, many of the expenses and the risk for developing disease can be reduced if one engages in regular physical activity. Thus, the benefits of an active lifestyle have been presented to the American public in a variety of programs such as Healthy People 2000 and in recommendations from the Surgeon General and the Centers for Disease Control and Prevention.

Although the benefits of a physically active lifestyle are widely recognized, the underlying biological and cellular mechanisms which mediate these positive changes are less well known. By integrating recent advances in biochemistry, molecular biology, and physiology, the discipline of exercise physiology is poised to take a more mechanistic approach to the study of the health-related benefits of regular physical activity. Such an approach, however, requires non-traditional interdisciplinary training that is not widely available. Typically, doctoral-level training in exercise physiology has been limited to a disciplinary approach within an exercise science department. Relatively few programs utilize an interdisciplinary curriculum and course of study to attack problems related to physical activity and disease prevention. The doctoral program outlined in this proposal is designed to train individuals to address these issues in an interdisciplinary fashion by providing an education in the field of bioenergetics.

PROGRAM REQUIREMENTS AND CURRICULUM

Admission

A masters degree with some formal classwork or training in the field of bioenergetics or a related field from an accredited institution is preferred. Preference will be given to candidates with strong science backgrounds who have integrated coursework and research. Candidates who have demonstrated research capabilities as demonstrated by presentations and/or publications will be strongly considered. Potential students will be interviewed either in-person or via telephone as part of the application process. Other admission requirements include:

- an acceptable score on the verbal, analytical, and quantitative sections of the general test of the graduate record exam (GRE);
- an essay describing the applicant's career goals and research interests which are consistent with the educational opportunities offered in this proposed degree program; and

- letters of reference from three persons who can attest to the applicant's academic competence and potential for doctoral-level study

In addition, for students whose first language is not English, a minimum acceptable score is required on the test of English as a foreign language (TOEFL). An acceptable score will be that delineated by the ECU graduate school.

Students will be expected to have a background needed to fulfill the prerequisites for the graduate courses required in this interdisciplinary program. For the exercise science and physiology cores, prerequisites will include a course in exercise physiology and a course in human physiology or general biology at either the graduate or undergraduate level. For entrance into the biochemistry core classes, the prerequisite requirements will be general chemistry, organic chemistry, and general biology at the undergraduate or graduate level. If these prerequisites have not been met, then admitted students will be required to take classes to address the deficiency prior to attending core classes where this background knowledge is a prerequisite. Upon admission to the program, the student with such deficiencies will have the full understanding that time to graduation may be extended. The semester hours taken to remedy deficiencies will not be counted in the 55 s.h. required for graduation.

Documents to be Submitted for Admission

- The following documents are required before final admission is approved
- completed application form for admission to graduate study at ECU,
- official transcripts from all colleges and universities attended,
- official scores on the general test (verbal, analytical, and quantitative) of the Graduate Record Exam (GRE),
- official TOEFL scores for students whose first language is not English,
- 3 letters of reference, and
- an essay describing the applicant's career goals and research interests.

Interested students will also be recommended to come to East Carolina University for an interview prior to consideration for admission.

Degree Requirements

The proposed doctoral program in bioenergetics is designed for students entering with a masters degree in a related field. The program requires a minimum of 55 semester hours of coursework including a minimum of 15 s.h. for dissertation research. This course of study can be achieved in approximately three years if the student enters with an appropriate knowledge base in the field of bioenergetics. Students from unrelated fields can be admitted; the course of study would likely be extended, however, to fulfill inherent deficiencies.

Required courses

There are 11 s.h. of required specific courses. These required courses are intended to provide the student with an interdisciplinary exposure to research, research topics, and statistics. Required courses are 6 s.h. of research rotations, 2 s.h. of seminar, and 3 s.h. of advanced statistics.

Two research rotations (3 s.h. each; courses are title Introduction to Research) must be completed to meet the 6 s.h. requirement. The research rotations are to be performed in laboratories selected by the student with the purpose of exposing the student to techniques which will expand the knowledge base of the individual. Research rotations will be available with faculty members in the departments of exercise and sport science, biochemistry, and physiology. Faculty members in other departments at ECU or other universities can also be selected and credit provided by existing research rotation courses or independent study. Rotations can be taken in any combination between various units, but must be performed with a different preceptor.

The seminar requirement is intended to expose the student to current research topics and literature in a study area of choice. A variety of seminars are available in the medical school and main campus at ECU. A seminar course is typically 1 s.h.; thus two seminar courses will be required for graduation. The seminar will be chosen by the student in consultation with the faculty mentor.

The statistics requirement (3 s.h.) is intended to provide an advanced exposure to statistical methods. Depending upon the statistical background of the student, courses selected to fulfill this requirement could include Applied Multivariate Analysis (BIOS 5450), or Experimental Design I or II (BIOS 6501 or 6502, 3 s.h.). A student with a deficient background in statistics will be required to take the required prerequisites for the course selected to meet this requirement.

Core requirements

Core requirements will involve coursework in each of the disciplines participating in this program. The specific requirements are 7 s.h. in the department of exercise and sport science (advanced techniques in bioenergetics, 3; bioenergetics, 4), 11 s.h. in biochemistry (biomolecular structure, 4; molecular biochemistry, 3; metabolism, 4) and 8 s.h. in physiology (graduate physiology 4,4).

The intent of requiring this core is to provide a basic background level of knowledge in the disciplines involved in the proposed doctoral program. These courses will provide the basis for the comprehensive examination, which will test the knowledge base of the student in bioenergetics. Knowledge in these areas will be vital in formulating and performing research in the interdisciplinary fashion needed in the field of bioenergetics. A student may petition the bioenergetics executive committee (for composition and

purposed of this committee, see Section VII) to omit a core class if previous similar coursework has been taken at the graduate level. The comprehensive examination can only be taken after the core requirements have been completed.

Dissertation

Fifteen s.h. of dissertation are required for completion of the program. Dissertation hours will be taken in the academic unit of the faculty mentor.

Electives

A wide variety of courses are available for electives.

Summary

Dissertation hours (15 s.h.) and required courses (6 s.h. laboratory rotations, 2 s.h. seminars, 3 s.h. statistics) comprise 26 s.h. of the 55 s.h. required for graduation. Core classes in EXSS (7 s.h.), biochemistry (11 s.h.), and physiology (8 s.h) bring the total of required coursework to 52 s.h of the 55 s.h. required for completion. Other additional courses can be added at the discretion of the student and faculty mentor. Such courses may be selected from offerings on both the main campus and in the medical school. Possible courses are too numerous to provide an inclusive list.

The general curriculum for an individual entering with a masters degree is outlined in the following table.

Sample Curriculum for Ph.D. in Bioenergetics

Year 1: Completion of core courses, seminar, research rotations.

Year 2: Fall &endash;electives, statistics, seminar, comprehensive exam; Spring - dissertation hours

Year 3: Dissertation hours

TOTAL: Minimum of 55 hrs of course work

This example is based upon a student entering with a masters degree in a related field. Research rotations (courses entitled Introduction to Research), seminars, and doctoral dissertation hours can be performed in any of the three disciplines (exercise science (EXSS; biochemistry, BIOC; physiology, PHYL) or other departments, if applicable.

	Fall	Spring	SS 1	SS 2
Yr 1	#EXSS 6210 (3)	#PHLY 6701 (4)	*Res. Rotation (3)	*Res.
	Rotation (3)			
	#EXSS 6211 (4)	#PHLY 6702 (4)	*Seminar (1)	
	#BIOC 6301 (4)	#BIOC 6320 (4)		
	#BIOC 6310 (3)			
Total	14 hrs	12 hrs	4 hrs	3 hrs = 33 hrs

Year 2	Electives (6)	*Dissertation (3)	*Dissertation (3)
	*Statistics (3)		
	*Seminar (1)		
Total	10 hrs	3 hrs	3 hrs = 16 hrs

Year 3	*Dissertation (3)	*Dissertation (3)	*Dissertation (3)
Total	3 hrs	3 hrs	3 hrs = 9 hrs

*Required class

#Core class

Total semester hours = 55

Minimum semester hours required for granting of the degree = 55

Core requirements: 7 semester hours in exercise and sport science (EXSS), 11 semester hours in biochemistry (BIOC), and 8 semester hours in physiology (PHYL). This core will provide the necessary background for the comprehensive exam and interdisciplinary research in bioenergetics.

Required courses: Research rotations can be taken in any combination between various departments, but must be performed with a different preceptor and total 6 s.h.. Students can also register for seminar on any topic relevant to bioenergetics; only 2 s.h. will, however, be applicable toward graduation. The statistics requirement consists of 3 s.h. of an advanced statistics course. A minimum of 15 s.h. of dissertation hours is required.

A comprehensive exam, which will test the fundamental knowledge of the student in relation to the interdisciplinary field of bioenergetics will be taken in the second year. The student is eligible for the comprehensive exam after 26 s.h. of coursework, which

must include the completion of the core courses, with at least a B average. Candidacy and the ability to register for 9000 level classes (dissertation) will be granted after the student satisfactorily passes the written and oral portions of the comprehensive exam.

Class Descriptions for Sample Course of Study

EXSS - Department of Exercise and Sport Science, School of Health and Human Performance

EXSS 6210 - Advanced Techniques in Bioenergetics (3). Prerequisites: exercise physiology or physiology; permission of instructor. Laboratory experiments and lectures will be used to provide an in-depth description and analysis of procedures used in bioenergetics research.

EXSS 6211 - Bioenergetics (4). Prerequisite: graduate exercise physiology or physiology; permission of instructor. A concise summary of bioenergetics using cellular and subcellular approaches. Focus will be upon metabolic perturbations evident with exercise and disease and the interactions between the two.

EXSS 6330 - Introduction to Research (3). Prerequisite: Permission of instructor. Each student is assigned to a faculty preceptor and is given the opportunity to learn the design of experimental protocols and to collaborate in some aspect of the preceptor's program. Course may be repeated; a maximum of 6 s.h. are applicable toward graduation.

EXSS 6335 - Seminar in Bioenergetics (1). Prerequisite: Permission of instructor. Student critiques of current literature in bioenergetics, concentrating on one topic per semester. Course may be repeated; a maximum of 2 s.h. are applicable toward graduation.

EXSS 9000 - Dissertation Research in Bioenergetics (3). Prerequisites: Admission to candidacy for doctoral degree in bioenergetics with committee approval. May be repeated. Students must register until the dissertation defense.

BIOC - Department of Biochemistry, School of Medicine

BIOC 6301 - Biomolecular Structure (4). Structure and physical and chemical properties of biomolecules, including an introduction to thermodynamics and kinetics of biological systems.

BIOC 6310 - Molecular Biochemistry (3). Replication, translation, and expression of genetic information and its regulation.

BIOC 6320 - Metabolism (4). Study of the metabolism of carbohydrates, lipids, and amino acids. Focus is on the integration of metabolism and its regulation in humans.

BIOC 6330 &endash; Introduction to Research (1-3). Each student is assigned to a faculty preceptor and is given the opportunity to learn the design of experimental protocols and to collaborate in some aspect of the preceptor's program.

BIOC 6335 &endash; Seminar in Biochemistry (1). Student critiques of current literature in biochemistry concentrating on one topic each semester.

BIOC 9000 &endash; Dissertation Research. Students are expected to register for this class starting with candidacy until defense.

PHLY - Department of Physiology, School of Medicine

PHLY 6701, 6702 - Graduate Physiology (4,4). Provides in-depth coverage of fundamental physiological principals of human and animal organ systems using recent and classical physiological research literature. This course provides extensive laboratory experience with emphasis on experimental techniques and design. Basic physiological processes will be dealt with through lectures and conferences concurrent with the lecture portion of Medical Physiology (PHLY 6700).

PHLY 6715 &endash; Seminar (1). Selected topics of current interest.

PHLY 6740 &endash; Introduction to Research (3). Collaborative or independent research in a variety of physiology speciality areas including research in preparation for the doctoral dissertation.

PHLY 9000 &endash; Dissertation Research.

FACULTY MENTORS AND RESEARCH AREAS AND INTERESTS

Department of Exercise and Sport Science

Joseph Houmard, PhD, 1988, Ball State University, Professor and Director Human Performance Laboratory, Cellular mechanisms of insulin resistance and effectiveness of exercise as an intervention.

Robert Hickner, 1995, Karolinska Institute, Assistant Professor, Regulation of blood flow in skeletal muscle and adipose tissue in relation to aging, obesity, and exercise.

Tibor Hortobagyi, PhD, 1990, University of Massachusetts, Amherst, Associate Professor, Director of Biomechanics Laboratory, Neuromuscular mechanisms of adaptation to exercise

Paul DeVita, 1987, University of Oregon, Associate Professor, Gait analysis in aging, lower leg injury and prevention.

Ronald Cortright, PhD, 1995, Kent State University, Assistant Professor, Regulation of glucose uptake and insulin action in skeletal muscle with diabetes, obesity and exercise.

Matthew Mahar, EdD, 1987, University of Houston, Associate Professor, Impact of physical activity and exercise on risk factors in children; predictors of cardiovascular fitness.

Department of Biochemistry

Hisham Barakat, PhD, 1971, University of Massachusetts, Amherst, Professor, Effects of obesity and exercise on lipoprotein metabolism.

Lynis Dohm, PhD, 1969, University of Kansas, Professor, Regulation of insulin sensitivity with exercise obesity and diabetes in skeletal muscle.

Department of Physiology

Robert Lust, PhD, 1968, Texas A&M University, Professor, and Chair, Cellular mechanisms responsible for cardiovascular disease and compromised cardiac function.

Robert Carroll, PhD, 1981, University of Medicine and Dentistry of New Jersey, Professor, Magnesium movement in relation to blood loss and shock.

Richard Ray, PhD, 1980, Medical College of Georgia, Professor, Functional organization of the somatosensory system.

Michael Van Scott, PhD, 1984, West Virginia University, Associate Professor, Investigation of mechanisms involved in electrolyte homeostasis in disease processes.

Other Departments

Michael Pfiefer, MD, 1973, University of Louisville, Professor, Section Head, Director of Diabetes and Obesity Center, Pharmaceutical and lifestyle interventions in the treatment of Type I and II diabetes.

Endocrinology

Walter Pories, MD, 1955, University of Rochester, Professor, Impact of weight loss via surgical intervention of insulin action and gastric secretions.

Joe Garry, MD, 1991, University of Minnesota, Associate Professor, Effects of exercise on lipoprotein levels and CHD.