

# Genomics, Phenomics, and Bioinformatics

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## Department Information

- **Program Director:**  
Changhui Yan, Ph.D.
- **Email:**  
Changhui.Yan@ndsu.edu
- **Department Web Site:**  
[www.ndsu.edu/gpb/](http://www.ndsu.edu/gpb/) (<http://www.ndsu.edu/gpb/>)
- **Application Deadline:**  
International applications are due May 1 for fall semester and October 1 for spring and summer semesters. Domestic applicants should apply at least one month prior to the start of classes.
- **Credential Offered:**  
Ph.D., M.S.
- **English Proficiency Requirements:**  
TOEFL iBT 71, IELTS 6; Duolingo 105

## Adviser and Supervisory Committee

During the first year, the student will form a supervisory committee and submit the Plan of Study to the Graduate School. The committee must include the student's major adviser, at least one other faculty member of the Genomics, Phenomics, and Bioinformatics program, and a third member from outside the student's home college. For Ph.D. students only, a fourth member of the committee serves as the Graduate School Representative (GSR). Requirements for GSR can be found here (<https://catalog.ndsu.edu/graduate/graduate-school-policies/doctoral-degree-policies/#planofstudysupervisorycommitteetext>).

## Master's Requirements

| Code                                                   | Title                                        | Credits |
|--------------------------------------------------------|----------------------------------------------|---------|
| <b>Functional Genomics - Thesis Option</b>             |                                              |         |
| Core Courses                                           |                                              |         |
| PLSC 611                                               | Genomics                                     | 3       |
| CSCI/MATH/STAT 732                                     | Introduction To Bioinformatics               | 3       |
| PLSC 721                                               | Genomics Techniques ( BIOC 674 is 3 credits) | 2       |
| or BIOC 674                                            | Methods of Recombinant DNA Technology        |         |
| 796 Current Topics in Genomics (1 credit, 2 semesters) |                                              | 2       |
| 790 Graduate Seminar                                   |                                              | 1       |
| Electives: At least one course from two elective areas |                                              | 9       |
| 798 Master's Thesis (6-10)                             |                                              |         |
| Total Credits                                          |                                              | 30      |

| Code                                                   | Title                                 | Credits |
|--------------------------------------------------------|---------------------------------------|---------|
| <b>Functional Genomics Comprehensive Study Option</b>  |                                       |         |
| PLSC 611                                               | Genomics                              | 3       |
| CSCI 732                                               | Introduction To Bioinformatics        | 3       |
| PLSC 721                                               | Genomics Techniques ( or)             | 2       |
| BIOC 674                                               | Methods of Recombinant DNA Technology | 3       |
| 796 Current Topics (1 credit, 2 semesters)             |                                       | 2       |
| 790 Graduate Seminar                                   |                                       | 1       |
| Electives: At least one course from two elective areas |                                       |         |
| 797 Master's Paper                                     |                                       | 4       |
| Total Credits                                          |                                       | 30      |

| Code                                                   | Title                                   | Credits   |
|--------------------------------------------------------|-----------------------------------------|-----------|
| <b>Bioinformatics - Thesis Option</b>                  |                                         |           |
| PLSC 611                                               | Genomics                                | 3         |
| CSCI 732                                               | Introduction To Bioinformatics          | 3         |
| CSCI 859                                               | Computational Methods in Bioinformatics | 3         |
| 796 Current Topics ( 1 credit, two semesters)          |                                         | 2         |
| 790 Graduate Seminar                                   |                                         | 1         |
| Electives: At least one course from two elective areas |                                         | 9         |
| 798 Master's Thesis                                    |                                         | 6-10      |
| <b>Total Credits</b>                                   |                                         | <b>30</b> |

| Code                                                   | Title                                   | Credits   |
|--------------------------------------------------------|-----------------------------------------|-----------|
| <b>Bioinformatics Comprehensive Study Option</b>       |                                         |           |
| PLSC 611                                               | Genomics                                | 3         |
| CSCI 732                                               | Introduction To Bioinformatics          | 3         |
| CSCI 859                                               | Computational Methods in Bioinformatics | 3         |
| 796 Current Topics (1 credit, 2 semesters)             |                                         | 2         |
| 790 Graduate Seminar                                   |                                         | 1         |
| Electives: At least one course from two elective areas |                                         | 15        |
| 797 Master's Paper                                     |                                         | 4         |
| <b>Total Credits</b>                                   |                                         | <b>30</b> |

| Code                                                   | Title                                                      | Credits   |
|--------------------------------------------------------|------------------------------------------------------------|-----------|
| <b>Phenomics Thesis Option</b>                         |                                                            |           |
| CSCI 679                                               | Introduction to Data Mining                                | 3         |
| ABEN 747                                               | Numerical Modeling of Environmental and Biological Systems | 3         |
| Physiology Elective                                    |                                                            | 3         |
| 796 Special Topics (1 credit, 2 semesters)             |                                                            | 2         |
| 790 Graduate Seminar                                   |                                                            | 1         |
| Electives: At least one course from two elective areas |                                                            | 9         |
| 798 Master's Thesis                                    |                                                            | 6-10      |
| <b>Total Credits</b>                                   |                                                            | <b>30</b> |

| Code                        | Title                                        | Credits |
|-----------------------------|----------------------------------------------|---------|
| <b>Physiology Electives</b> |                                              |         |
| ANSC 663                    | Physiology of Reproduction                   | 3       |
| BIOL 660                    | Animal Physiology                            | 3       |
| BIOL 662                    | Physiological Ecology                        | 3       |
| BIOL 664                    | Endocrinology                                | 3       |
| BIOL 683                    | Cellular Mechanisms of Disease               | 3       |
| BIOL 825                    | Biology of Aging                             | 3       |
| BIOL 861                    | Advanced Physiology - Physiology of Extremes | 3       |
| MICR 650                    |                                              | 3       |
| MICR 680                    | Microbial Physiology                         | 3       |
| PPTH 751                    | Physiology Of Plant Disease                  | 3       |
| PLSC 686                    | Applied Crop Physiology                      | 3       |
| PLSC 750                    | Crop Stress Physiology                       | 3       |
| PSCI 747                    | Cardiovascular Pharmacology                  | 3       |
| PSCI 762                    | Advanced Biopharmaceutics                    | 2       |
| PSCI 765                    | Cancer Cell Biology                          | 2       |
| <b>Gene Expression</b>      |                                              |         |

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|--------------------------------------------------------------------------|-----------------------------------------------------------------|---|
| BIOC 660                                                                 | Foundations of Biochemistry and Molecular Biology I             | 3 |
| BIOC 683                                                                 | Cellular Signal Transduction Processes and Metabolic Regulation | 3 |
| BIOC 719                                                                 | Molecular Biology of Gene Expression and Regulation             | 3 |
| BIOC 723                                                                 | Structural Basis of Membrane Transport and Signaling            | 3 |
| BIOL 682                                                                 | Developmental Biology                                           | 3 |
| BIOL 820                                                                 | Advanced Cell Biology                                           | 3 |
| MICR 775                                                                 |                                                                 | 3 |
| PLSC 731                                                                 | Plant Molecular Genetics                                        | 3 |
| <b>Genetics and Genomics Electives</b>                                   |                                                                 |   |
| ANSC 657                                                                 |                                                                 | 3 |
| ANSC 750                                                                 |                                                                 | 1 |
| ANSC 751                                                                 |                                                                 | 1 |
| ANSC 752                                                                 |                                                                 | 1 |
| BIOL 679                                                                 | Biomedical Genetics and Genomics                                | 3 |
| BIOL 859                                                                 | Evolution                                                       | 3 |
| BIOL 860                                                                 | Evolutionary Ecology                                            | 3 |
| BIOL 862                                                                 | Environment and Adaptation                                      | 3 |
| MICR 681                                                                 | Microbial Genomics with Computational Laboratory                | 3 |
| MICR 682                                                                 | Microbial Genetics                                              | 3 |
| MICR 783                                                                 | Advanced Bacterial Genetics and Phage                           | 3 |
| PLSC 631                                                                 | Intermediate Genetics (required for Functional Genomics Option) | 3 |
| PLSC 741                                                                 |                                                                 | 4 |
| PLSC 751                                                                 | Advanced Plant Genetics                                         | 3 |
| PLSC 782                                                                 | Population and Quantitative Genetics                            | 4 |
| PPTH 755                                                                 | Population Biology of Plant Pathogens                           | 3 |
| PPTH 759                                                                 | Host-Parasite Genetics                                          | 3 |
| PSCI 617                                                                 | Pharmacogenomics                                                | 2 |
| <b>Computer Science, Statistics, and Computational Biology Electives</b> |                                                                 |   |
| ANSC 850                                                                 | Linear Models in Animal Breeding                                | 1 |
| ANSC 851                                                                 | Genetic Prediction                                              | 1 |
| ANSC 852                                                                 | Applied Variance Component Estimation                           | 1 |
| ANSC 856                                                                 |                                                                 | 1 |
| BIOL 842                                                                 | Quantitative Biology                                            | 3 |
| BIOL 877                                                                 | Analysis of Population and Demographic Data                     | 3 |
| CSCI 679                                                                 | Introduction to Data Mining                                     | 3 |
| CSCI 724                                                                 | Survey of Artificial Intelligence                               | 3 |
| CSCI 736                                                                 | Computational Intelligence                                      | 3 |
| CSCI 765                                                                 | Introduction to Database Systems                                | 3 |
| CSCI 879                                                                 |                                                                 | 3 |
| MATH 630                                                                 | Graph Theory                                                    | 3 |
| MATH 636                                                                 | Combinatorics                                                   | 3 |
| MATH 684                                                                 | Mathematical Methods of Biological Processes                    | 3 |
| MATH 830                                                                 | Graph Theory                                                    | 3 |
| MATH 839                                                                 | Topics in Combinatorics and Discrete Mathematics                | 3 |
| MATH 867                                                                 | Topics in Applied Mathematics                                   | 3 |
| MICR 724                                                                 |                                                                 | 3 |
| PLSC 749                                                                 | Applied Plant Molecular Breeding                                | 3 |
| PH 674                                                                   | Epidemiology                                                    | 3 |
| PH 706                                                                   | Essentials of Epidemiology                                      | 3 |
| PH 731                                                                   | Biostatistics                                                   | 3 |
| PH 750                                                                   | Epidemiologic Methods I                                         | 2 |
| PH 752                                                                   | Epidemiologic Methods II                                        | 2 |

|                                       |                                                                                |   |
|---------------------------------------|--------------------------------------------------------------------------------|---|
| PLSC 724                              | Field Design I                                                                 | 3 |
| STAT 650                              | Stochastic Processes                                                           | 3 |
| STAT 661                              | Applied Regression Models (required for Bioinformatics Ph.D. option)           | 3 |
| STAT 711                              | Basic Computational Statistics using R                                         | 3 |
| STAT 712                              | Applied Statistical Machine Learning                                           | 3 |
| STAT 713                              | Introduction to Data Science                                                   | 3 |
| STAT 714                              | Statistical Big Data Visualization                                             | 3 |
| STAT 725                              | Applied Statistics                                                             | 3 |
| STAT 764                              | Multivariate Methods                                                           | 3 |
| STAT 840                              | Introduction to Statistical Design and Analysis of Gene Expression Experiments | 3 |
| STAT 851                              | Bayesian Statistical Inference                                                 | 3 |
| STAT 860                              | Statistical Machine Learning                                                   | 3 |
| <b>Modeling and Sensing Electives</b> |                                                                                |   |
| ABEN 747                              | Numerical Modeling of Environmental and Biological Systems                     | 3 |
| ABEN 758                              | Applied Computer Imaging and Sensing for Biosystems                            | 3 |
| CE 725                                | Biomaterials-Materials in Biomedical Engineering                               | 3 |
| CSCI 628                              | Artificial Intelligence, Ethics, and the Environment                           | 3 |
| GEOG 655                              | Introduction to Geographic Information Systems                                 | 4 |
| GEOG 656                              | Advanced Geographic Information Systems                                        | 3 |
| GEOG 670                              | Remote Sensing                                                                 | 3 |
| GEOG 680                              | Geographic Information Systems Pattern Analysis and Modeling                   | 3 |
| PAG 654                               | Applications of Precision Agriculture                                          | 3 |

## Doctoral Requirements

| Code                                                      | Title                                       | Credits  |
|-----------------------------------------------------------|---------------------------------------------|----------|
| <b>Functional Genomics</b>                                |                                             |          |
| PLSC 611                                                  | Genomics                                    | 3        |
| CSCI 732                                                  | Introduction To Bioinformatics              | 3        |
| PLSC 721                                                  | Genomics Techniques (or)                    | 2        |
| or BIOC 674                                               | Methods of Recombinant DNA Technology       |          |
| 796 Current Topics (1 credit, 3 semesters)                |                                             | 3        |
| 790 Graduate Seminar (1 credit, 2 semesters)              |                                             | 2        |
| <b>Requested Core Courses (unless in M.S. transcript)</b> |                                             |          |
| PLSC 631                                                  | Intermediate Genetics                       | 3        |
| STAT 726                                                  | Applied Regression and Analysis of Variance | 3        |
| Graduate Evolution Course                                 |                                             |          |
| Electives: At least one course from three elective areas  |                                             | 15       |
| 899 Doctoral Dissertation                                 |                                             | up to 90 |

| Code                                                     | Title                                   | Credits |
|----------------------------------------------------------|-----------------------------------------|---------|
| <b>Bioinformatics Option</b>                             |                                         |         |
| PLSC 611                                                 | Genomics                                | 3       |
| CSCI 732                                                 | Introduction To Bioinformatics          | 3       |
| CSCI 859                                                 | Computational Methods in Bioinformatics | 3       |
| 796 Current Topics (1 credit, 3 semesters)               |                                         | 3       |
| 790 Graduate Seminar (1 credit, 2 semesters)             |                                         | 2       |
| <b>Required Core Courses (unless in M.S. transcript)</b> |                                         |         |
| CSCI 679                                                 | Introduction to Data Mining             | 3       |
| CSCI 765                                                 | Introduction to Database Systems        | 3       |
| STAT 661                                                 | Applied Regression Models               | 3       |

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|----------------------------------------------------------|----------|
| Electives: At least one course from three elective areas | 15       |
| 899 Doctoral Dissertation                                | up to 90 |

| Code                                                     | Title                                                      | Credits  |
|----------------------------------------------------------|------------------------------------------------------------|----------|
| <b>Phenomics Option</b>                                  |                                                            |          |
| CSCI 679                                                 | Introduction to Data Mining                                | 3        |
| ABEN 747                                                 | Numerical Modeling of Environmental and Biological Systems | 3        |
| Physiology Course                                        |                                                            | 3        |
| 796 Current Topics (1 credit, 3 semesters)               |                                                            | 3        |
| 790 Graduate Seminar (1 credit, 2 semesters)             |                                                            | 2        |
| STAT 726                                                 | Applied Regression and Analysis of Variance                | 3        |
| CSCI 765                                                 | Introduction to Database Systems                           | 3        |
| Electives: At least one course from three elective areas |                                                            | 15       |
| 899 Doctoral Dissertation                                |                                                            | up to 90 |

| Code                                   | Title                                                           | Credits |
|----------------------------------------|-----------------------------------------------------------------|---------|
| <b>Physiology Electives</b>            |                                                                 |         |
| ANSC 663                               | Physiology of Reproduction                                      | 3       |
| BIOL 662                               | Physiological Ecology                                           | 3       |
| BIOL 664                               | Endocrinology                                                   | 3       |
| BIOL 683                               | Cellular Mechanisms of Disease                                  | 3       |
| BIOL 825                               | Biology of Aging                                                | 3       |
| MICR 650                               |                                                                 | 3       |
| MICR 680                               | Microbial Physiology                                            | 3       |
| MICR 785                               |                                                                 | 3       |
| PPTH 751                               | Physiology Of Plant Disease                                     | 3       |
| PLSC 686                               | Applied Crop Physiology                                         | 3       |
| PLSC 750                               | Crop Stress Physiology                                          | 3       |
| PSCI 747                               | Cardiovascular Pharmacology                                     | 3       |
| PSCI 762                               | Advanced Biopharmaceutics                                       | 2       |
| PSCI 765                               | Cancer Cell Biology                                             | 2       |
| <b>Gene Expression Electives</b>       |                                                                 |         |
| BIOC 660                               | Foundations of Biochemistry and Molecular Biology I             | 3       |
| BIOC 683                               | Cellular Signal Transduction Processes and Metabolic Regulation | 3       |
| BIOC 719                               | Molecular Biology of Gene Expression and Regulation             | 3       |
| BIOC 723                               | Structural Basis of Membrane Transport and Signaling            | 3       |
| BIOL 682                               | Developmental Biology                                           | 3       |
| BIOL 820                               | Advanced Cell Biology                                           | 3       |
| MICR 775                               |                                                                 | 3       |
| PLSC 731                               | Plant Molecular Genetics                                        | 3       |
| <b>Genetics and Genomics Electives</b> |                                                                 |         |
| ANSC 657                               |                                                                 | 3       |
| ANSC 750                               |                                                                 | 1       |
| ANSC 751                               |                                                                 | 1       |
| ANSC 752                               |                                                                 | 1       |
| BIOL 679                               | Biomedical Genetics and Genomics                                | 3       |
| BIOL 859                               | Evolution                                                       | 3       |
| BIOL 860                               | Evolutionary Ecology                                            | 3       |
| BIOL 862                               | Environment and Adaptation                                      | 3       |
| MICR 681                               | Microbial Genomics with Computational Laboratory                | 3       |

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|--------------------------------------------------------------------------|--------------------------------------------------------------------------------|---|
| MICR 682                                                                 | Microbial Genetics                                                             | 3 |
| PPTH 755                                                                 | Population Biology of Plant Pathogens                                          | 3 |
| PPTH 759                                                                 | Host-Parasite Genetics                                                         | 3 |
| PLSC 631                                                                 | Intermediate Genetics                                                          | 3 |
| PLSC 741                                                                 |                                                                                | 3 |
| PLSC 751                                                                 | Advanced Plant Genetics                                                        | 3 |
| PLSC 782                                                                 | Population and Quantitative Genetics                                           | 4 |
| PSCI 617                                                                 | Pharmacogenomics                                                               | 2 |
| <b>Computer Science, Statistics, and Computational Biology Electives</b> |                                                                                |   |
| ANSC 850                                                                 | Linear Models in Animal Breeding                                               | 1 |
| ANSC 851                                                                 | Genetic Prediction                                                             | 1 |
| ANSC 852                                                                 | Applied Variance Component Estimation                                          | 1 |
| ANSC 856                                                                 |                                                                                | 1 |
| BIOL 842                                                                 | Quantitative Biology                                                           | 3 |
| BIOL 877                                                                 | Analysis of Population and Demographic Data                                    | 3 |
| CSCI 679                                                                 | Introduction to Data Mining                                                    | 3 |
| CSCI 724                                                                 | Survey of Artificial Intelligence                                              | 3 |
| CSCI 736                                                                 | Computational Intelligence                                                     | 3 |
| CSCI 765                                                                 | Introduction to Database Systems                                               | 3 |
| CSCI 879                                                                 |                                                                                | 3 |
| MATH 630                                                                 | Graph Theory                                                                   | 3 |
| MATH 636                                                                 | Combinatorics                                                                  | 3 |
| MATH 830                                                                 | Graph Theory                                                                   | 3 |
| MATH 839                                                                 | Topics in Combinatorics and Discrete Mathematics                               | 3 |
| MATH 864                                                                 | Calculus Of Variations                                                         | 3 |
| MATH 867                                                                 | Topics in Applied Mathematics                                                  | 3 |
| MICR 724                                                                 |                                                                                | 3 |
| PLSC 749                                                                 | Applied Plant Molecular Breeding                                               | 3 |
| PH 674                                                                   | Epidemiology                                                                   | 3 |
| PH 706                                                                   | Essentials of Epidemiology                                                     | 3 |
| PH 731                                                                   | Biostatistics                                                                  | 3 |
| PH 750                                                                   | Epidemiologic Methods I                                                        | 2 |
| PH 752                                                                   | Epidemiologic Methods II                                                       | 2 |
| PLSC 724                                                                 | Field Design I                                                                 | 3 |
| STAT 650                                                                 | Stochastic Processes                                                           | 3 |
| STAT 661                                                                 | Applied Regression Models                                                      | 3 |
| STAT 711                                                                 | Basic Computational Statistics using R                                         | 3 |
| STAT 712                                                                 | Applied Statistical Machine Learning                                           | 3 |
| STAT 713                                                                 | Introduction to Data Science                                                   | 3 |
| STAT 714                                                                 | Statistical Big Data Visualization                                             | 3 |
| STAT 725                                                                 | Applied Statistics                                                             | 3 |
| STAT 726                                                                 | Applied Regression and Analysis of Variance                                    | 3 |
| STAT 764                                                                 | Multivariate Methods                                                           | 3 |
| STAT 840                                                                 | Introduction to Statistical Design and Analysis of Gene Expression Experiments | 3 |
| STAT 851                                                                 | Bayesian Statistical Inference                                                 | 3 |
| STAT 860                                                                 | Statistical Machine Learning                                                   | 3 |
| <b>Modeling and Sensing Electives</b>                                    |                                                                                |   |
| ABEN 747                                                                 | Numerical Modeling of Environmental and Biological Systems                     | 3 |
| ABEN 758                                                                 | Applied Computer Imaging and Sensing for Biosystems                            | 3 |
| CE 725                                                                   | Biomaterials-Materials in Biomedical Engineering                               | 3 |
| CSCI 628                                                                 | Artificial Intelligence, Ethics, and the Environment                           | 3 |
| GEOG 655                                                                 | Introduction to Geographic Information Systems                                 | 4 |

|          |                                                              |   |
|----------|--------------------------------------------------------------|---|
| GEOG 656 | Advanced Geographic Information Systems                      | 3 |
| GEOG 665 | Remote Sensing of the Environment                            | 3 |
| GEOG 670 | Remote Sensing                                               | 3 |
| GEOG 680 | Geographic Information Systems Pattern Analysis and Modeling | 3 |
| PAG 654  | Applications of Precision Agriculture                        | 3 |

## Examinations

1. **Qualifying Exam (Ph.D. only):** This exam consists of written and oral portions. The student will complete a written exam that emphasizes the application of materials presented in the core courses. The members of the graduate program faculty will submit these questions. The oral exam will be administered by the student's supervisory committee and will focus on material beyond the core courses that are specific to the research of the student. Upon completion of the qualifying exam, the student will be accepted as a Ph.D. candidate.
2. **Final Exam:** The final exam will be an oral defense of the student's research results. The student's supervisory committee will administer the exam.