

**Self-Study Document of the
Interdisciplinary Graduate Certificate
in Statistical Genetics
offered by the Statistical Genetics faculty group
under the authority of the graduate faculty of the
Departments of Statistics and Biostatistics
University of Washington**

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A: Overview

The Interdisciplinary Graduate Certificate in Statistical Genetics is one component of the education and research training in statistical genetics offered by the graduate faculty of the Departments of Statistics and Biostatistics. The Certificate program complements the PhD pathways in Statistical Genetics that are offered by each department. The Statistics Department graduate programs were reviewed in 1998-9 and Biostatistics in 2002-3. Graduate training in Statistical Genetics in each department was reviewed as a part of those departmental program reviews.

The Certificate program is open to all matriculated graduate students of the University of Washington, subject to meeting the prerequisite background in Statistics and in Genetics and subject to the approval of the student's primary graduate degree program. Broadly, the program serves two groups of students: PhD students in other programs, and MS students in Statistics and Biostatistics seeking additional training and qualification in the area of Statistical Genetics.

B: Organization and Resources

B1: The Certificate and Degree Training Faculty

The Statistical Genetics faculty consist of an informal group of those working in statistical genetics theory and methodology at the University of Washington. While the Certificate and other training is based in Statistics and Biostatistics, faculty based primarily in Genome Sciences and in Medical Genetics are key to our endeavor. A list of the core statistical genetic faculty is given in Appendix 1, and their brief CVs are included as Appendix 5.

B2: The Certificate Advisory Board

Additionally, the Certificate program has an Advisory Board, consisting of the chairs of Statistics and Biostatistics (ex officio), and several other UW faculty eminently qualified to oversee this program. The advisory board members are listed in Appendix 2. The advisory board has not seen the need to be very active. However, since January 2006 the chair of Biostatistics is Dr. Bruce Weir, an eminent statistical geneticist and welcome addition to the Statistical Genetics faculty roster. With his participation, it is hoped that the advisory board may take a more active overview role.

B3: Program admission, progress and completion

There are essentially no costs attributable to the Certificate program alone. The Certificate program is open only to already matriculated graduate students, so that administrative costs are minimal. Students who are in the courses and have indicated an interest in completing the Certificate are assigned a Statistical Genetics advisor from among the Statistical Genetics faculty, to assist them in this task. As they near completion of the requirements, they complete a standard form, and submit this (either directly or through their departments) to the coordinator (currently Thompson). When requirements are completed, the Graduate School is informed, and the Certificate award noted in the student's UW record.

B4: The Curriculum Committee and the Certificate Coordinator

The courses of the Certificate program (see section C) are offered by Statistics, Biostatistics or Genome Sciences, and serve other students in addition to those intending to take the Certificate. There is a Statistical Genetics Curriculum Committee: this currently (2004-6) consists of Professors Stephens, Storey, Thompson, and Wijsman. (Weir replaced Stephens in August 2006.) The primary purpose of the curriculum committee is continuing oversight and coordination of the core course sequence STAT/BIOST 550-551-552, and of its relationship to the Genome Sciences courses also taken by the Statistical Genetics students. The sequence serves 1) The Statistics and Biostatistics students in Statistical Genetics Ph.D. pathways, 2) students in the Statistical Genetics Certificate program, and 3) other interested graduate students from a variety of UW graduate programs (see section C).

The College of Arts and Sciences provided the Statistics Department with 2 years of RA support for development of computing labs and software materials for the Statistical Genetics core course sequence in 2000-2002. In addition to providing the teaching support for STAT/BIOST 550, Statistics has also provided Professor Thompson one-course (25%) teaching relief for all her Statistical Genetics and Mathematical Biology teaching and student-advising related activity in each of the years since 2000 (except 2002-3, when she was on sabbatical). Coordination of the Interdisciplinary Certificate program is one part of this activity.

B5: Resources

Just as there are no costs attributable directly to the Certificate program alone, so also are there no resources. The Statistical Genetics faculty all have strong well-funded research programs, but available funding is, of course, directed towards the PhD students in their departmental programs. In the case of Statistics and Biostatistics faculty, these are often students in the Statistical Genetics PhD pathways. Statistical Genetics is a component of the NIH-funded Genome Sciences Training Grant (GTG). Professor Wijsman has served on the review committee for applications for that training grant, and a total of 7 Statistics or Biostatistics Ph.D. students working in Statistical Genetics have been supported on the GTG over the years 2000-2006. Again, however, this is not directly related to the Certificate program.

In 2000, Thompson was awarded a small (\$25K) University of Washington Tools for Transformation grant for the development of education in Statistical Genetics at the University of Washington. This award was vital to early success, paying for administrative assistance towards the original Ph.D pathway and Certificate program applications, and towards an NIH training grant application. The grant also provided some support for development of our web site (<http://depts.washington.edu/statgen/>), and other small costs associated with development of research and education in Statistical Genetics at the University of Washington. Even where it has not been necessary to call on these funds (for example, in support of our workshops: see section E), their existence has been instrumental in enabling us to initiate activities. Currently (2006), there remains a balance of \$2,455.

C: Certificate Curriculum and Teaching

The curriculum for the Interdisciplinary Certificate in Statistical Genetics is the same as the core statistical genetics curriculum required of the Statistics and Biostatistics students in the statistical genetics PhD pathways. Those pathway students of course meet also the other curriculum requirements of their respective PhD programs, while the Certificate students have also the requirements of their primary graduate program. The Certificate curriculum consists of 5 courses, and a graduate seminar. Appendix 3 lists the course offerings, instructors, and enrollments since the 1999-2000 AY. Where available the overall student evaluation of each course offering is also given: these evaluations are on a 5.0 point scale.

C1: The core course sequence: STAT/BIOST 550-1-2

The core course sequence in Statistical Genetics (STAT/BIOST 550-1-2) has been developed by the statistical genetics faculty and taught each year since 2000. The first course (550: Fall) deals with discrete Mendelian traits, the second (551: Winter) with methods for the analysis of quantitative (continuous) genetic traits, and the third (552: Spring) addresses the design and analysis of genetic studies. Further details are given at our web site: http://depts.washington.edu/statgen/Statgen/core_curric.shtml.

Each course depends strongly on earlier courses in the sequence, and the majority of students take them over one academic year, although some defer 552 and a few may be permitted to take 552 having as yet taken only one of 550 or 551. The main task of the Curriculum Committee (see B4) is to ensure ongoing coordination and coherence of the core sequence.

The enrollments in the core sequence are stable, declining slightly over the 3-course sequence (as might be expected). The over-enthusiastic levels of enrollment in STAT/BIOST 550 in Fall 2001 and Fall 2002 have fortunately declined: about 12 students is the maximum that can be readily taught in a course of this nature. Enrollments in 552 are smaller, but the intensive hands-on and project work of this course also make that desirable: more than about 8 students significantly changes the nature of such a course. The student evaluations show a high level of satisfaction with the courses. The one exception was STAT/BIOST 551 in 2002 which was taught by a junior visitor, Dr. Henderson. We are extremely grateful to Dr. Henderson for filling this unexpected and sudden gap in our teaching rota.

C2: The Genome Sciences core Certificate courses

The remaining two courses of the Certificate curriculum are courses offered by the Department of Genome Sciences. The first is a course in Population Genetics (GENOME 562) which is offered only in odd years. This causes occasional scheduling problems for students trying to complete the Certificate as taking both STAT/BIOST 552 and GENOME 562 in the same Spring quarter may be incompatible with the requirements of their primary graduate program. However, provided the student plans ahead and, for example, defers 552, few difficulties arise. The other course is GENOME 540, which is the first of two courses that form the core of the program in Computational Molecular Biology (see section D).

The Statistical Genetics students are a minority of the students in these two Genome Sciences courses, but a significant and welcome minority (according to the instructors Felsenstein and Green,

who are both members of the core Statistical Genetics faculty). The enrollment counts and student evaluations are thus only partially reflective of Statistical Genetics students, but both are clearly healthy (Appendix 3).

C3: The Statistical Genetics Seminar: BIOST 580B

The seminar requirement is fulfilled by one year of participation in the weekly Statistical Genetics seminar, initiated by Thompson and Wijsman in 1988, and offered as BIOST 580B every AY quarter since 1992. A schedule the seminar activity since 1997 is given at <http://courses.washington.edu/b580b/previous.shtml>. Student enrollments since 1999 are given in Appendix 3, and several faculty members and some additional unregistered postdoctoral researchers also participate regularly.

The seminar is primarily of journal-club format, although a couple of sessions each quarter are normally devoted to presentation of ongoing research of students or postdocs or to preliminary presentation of talks or posters for upcoming meetings. The focus or topics for each quarter are decided in group discussion at the first meeting, a schedule of presenting students is established, and students (with assistance/advice) select appropriate papers from the recent literature for their session. These are read in advance of the session by all participants, but the discussion is led by the scheduled students.

In recent years, we have adopted a format where two students lead the discussion each week. This has had many advantages. First, all students then present each quarter. Second, more experienced students are paired with newcomers: the more senior student helping a newer student to understand the paper is an excellent learning experience for both parties. Third, the need to present jointly leads to more intensive and constructive discussion between the presenters in advance of the seminar, and a better seminar discussion.

C4: Prerequisites for the program

There is also a prerequisite of two undergraduate-level courses in Genetics or Genome Sciences, and one each of Probability (needed for STAT/BIOST 550), Statistics (needed for STAT/BIOST 551), and Computer Programming (needed primarily for GENOME 540). Specific UW courses that may serve as prerequisites are listed on our web site (<http://depts.washington.edu/statgen/Statgen/background.shtml>), but the majority of UW graduate students will have completed their undergraduate work elsewhere. Any reasonable equivalent is accepted, and any instructor may give permission for a student not having the prerequisite to take a course. Thus the prerequisites have seldom been a significant hurdle. Students from the mathematical and computational sciences often take their second Genomics/Genetics prerequisite course concurrently with other Certificate courses, while those from the Biological sciences may struggle with limited understanding of probability or of statistics, but their scientific knowledge and understanding carry them through.

C5: Curriculum challenges for the Certificate

Note that there is no course that is offered only to the Certificate students. The core course sequence is developed for our Statistical Genetics PhD students, while the Statistical Genetics Seminar

continues to bring together a diverse group of faculty, postdocs and students on a weekly basis. The two courses in Genome Sciences are important for our students, and our students contribute to them, but these two courses would be offered regardless of the existence of the Statistical Genetics Certificate.

This is both a plus and a minus. The advantage is that it contributes to the “zero cost” operation of the Certificate program, and also to the diversity of well-qualified students in these courses which make them a pleasure to teach (see section D). The disadvantage is the same; the very different levels of background knowledge of the students. The core course must be of sufficient substance and at a level to serve Statistics and Biostatistics Ph.D. pathway students. At the same time it must not leave the Certificate students behind. We believe that the instructors have coped well with this challenge, as the enrollments and student evaluations continue to indicate.

D: Relationships with other units

Both the Statistical Genetics training in general and the interdisciplinary Certificate program in particular involve faculty and students in multiple units. The core statistical genetics faculty have their homes in 4 departments in 3 schools/colleges (see Appendix 1). Our first Certificate alumnus was a PhD student in Computer Science & Engineering; a different department in yet a different college.

Our closest links are with the interdisciplinary program in Computational Molecular Biology (COMBI), which involves several Departments, but predominantly Genome Sciences and Computer Science & Engineering (see <http://depts.washington.edu/cmolbiol/>). The GENOME 540 course taken by the Statistical Genetics students is the first of two core courses for the COMBI program, and several Statistical Genetics (StatGen) faculty and students are regular participants in the COMBI seminar, the core seminar for that program. Both COMBI and StatGen became components of the renewed NIH-funded Genome Training Grant (GTG) in 2000, then under the former Department of Molecular Biotechnology, and continue under the 2005 renewal, now under the new Department of Genome Sciences. Most of the Statistical Genetics faculty have either primary or adjunct appointments in Genome Sciences, and advise or teach both StatGen and COMBI students.

Another group with which several StatGen faculty and students have participated is the Mathematical Biology (Mathbio) group, formerly in the Department of Zoology, now Department of Biology. This group brings together a students and faculty working in diverse areas of mathematical biology from the cell to the ecosystem, including, in addition to all the previously mentioned programs, Applied Mathematics, Molecular and Cell Biology, Physiology, and Quantitative Ecology. At the twice weekly meetings (now offered each AY quarter as the 2-credit course BIOL 510), students present on both the mathematical modeling and on the biology of their research. Learning to present substantive material to this diverse group is a skill which all interdisciplinary scientists must learn.

Another UW program which addresses some of the same subject matter as our Statistical Genetics (StatGen) program is Public Health Genetics (PHG) (<http://depts.washington.edu/phgen/>) in the School of Public Health, but the two programs are quite differently focused. The formal overlap of the programs is only through the Department of Biostatistics, whose faculty have taught in the PHG program and which is the home Department of the second and third (551 and 552) of the StatGen core course sequence. The goal of the

PHG graduate programs is to address ethical, legal, and social issues arising in analyses of human genetic data. Our program is focused towards the genetic and genomic science, and the statistical methodology of such analyses. The closest overlap is a PHG course, originally developed and taught by Dr. Wijsman as BOST 532, from which our StatGen course STAT/BOST 552 has evolved. The PHG course serves the important role of introducing PHG students to available statistical analysis methods and software. Our core course sequence requires students to have a much stronger statistical background, and is focused towards an understanding of the statistical methodology underlying available software. It addresses the genetic and genomic science that will enable students to assess and select appropriate methods of analysis, and to develop new ones. Each program serves an important role, and some individual students may benefit from taking courses in both programs.

A final measure of StatGen's relationships and impact on other units on campus is the variety of programs which our core Statistical Genetics courses serve. A single example will suffice: of the eleven registered students completing STAT/BOST 550 in Fall 2005

- 2 were students in Statistics
- 2 were students in Biostatistics
- 2 were students in Genome Sciences
- 1 was a student in Computer Science & Engineering
- 1 was a student in Medical Informatics
- 1 was a PhD researcher in Molecular and Cell Biology (non-matriculated)
- 1 was a student in Epidemiology and
- 1 was a student in Virology

Despite the variety, the students formed a cohesive group, each bringing the strengths of their backgrounds to the class and learning much from each other.

E: The Statistical Genetics Students

Broadly, the interdisciplinary Certificate program serves two groups of students: PhD students in other programs, and MS students in Statistics and Biostatistics seeking additional training and qualification in the area of Statistical Genetics. In terms of the Certificate alumni (Appendix 4), the majority have been of the latter category, but in terms of students in our core course sequence there are least as many of the former. Appendix 4 also provides some information on the current positions of Certificate alumni. Note that Statistics and Biostatistics in the Statistical Genetics Ph.D pathways do not take the Certificate degree: there have been 8 such PhD graduates since 2002.

While the number and variety of students in the Certificate courses is very healthy, the number of completed Certificates is small. The existence of the Certificate is a clear attraction for students interested in this area, but it is clear that only a few wish to complete the full course load. While we feel the current courses are a minimum for a substantive qualification in this area, there is no doubt that the load is heavy for students also pursuing their primary degree program.

Failure to complete the Certificate should not be regarded as failure of either the program or the student. Many students have gained valuable experience from the StatGen courses which they are putting to good use in their ongoing studies or research work. Three examples suffice:

- A PhD student in Epidemiology completed her PhD with one Certificate requirement remaining. (She is also an M.D. and an M.S. in Biostatistics.) She is now a research associate working in Genetic

Epidemiology in a Statistical Medical Genetics group. Her biological and epidemiological expertise, together with the Statistical Genetics education she received make her an outstanding contributor to the group.

- A PhD student in Biostatistics took almost all the requirements of the Certificate program, and is now pursuing her PhD research studies in a related area working at the FHCRC. Again, although she did not complete the Certificate, the core course sequence attracted her to this subject area and she gained her basic knowledge of Statistical Genetics through our courses.

- A graduate student in Statistics, working in Statistical Genetics, decided to take time out after her M.S. degree to work with the Peace Core. She had planned on completing the Certificate, but had to drop the final course (GENOME 540) in order to complete her Statistics M.S. requirements on time.

We regard these three students as successes, not failures, of our program.

The Statistical Genetics Certificate program does not matriculate students. It does not have the resources for any admissions procedure, and generally this causes no problems. Our primary service is to already matriculated graduate students of the University of Washington. However, there have been several requests and inquiries from State of Washington employees working as research scientists at UW or elsewhere (e.g. NW Fisheries). We have welcomed these non-matriculated students into our classes, and they have been keen participants and brought a wider perspective to class discussions. Currently, however, they cannot receive the recognition of a Certificate award.

F: Recruitment and Diversity

The Certificate program does not matriculate students, nor actively recruit specifically to the Certificate program. We welcome all qualified participants, but are dependent on the students' primary programs relative to diversity issues. The StatGen core sequence is usually fairly evenly balanced with regard to gender, often with usually slightly more women than men. Our Certificate graduates (Appendix 4) are 4 men and 3 women. (Our StatGen pathway PhD graduates are 5 men and 3 women, and include one African American.)

Although we do not recruit students specifically to our Statistical Genetics programs, all the StatGen faculty are actively engaged in recruiting students with an interest in this subject area to the graduate programs of their respective Departments of Statistics, Biostatistics and Genome Sciences. Additionally, we all work hard to make students from the mathematical sciences aware of the research areas of Statistical Genetics and Computational Molecular Biology.

StatGen and COMBI have jointly hosted two workshops aimed at introducing senior undergraduates and beginning graduate students from around the Pacific Northwest region to current research in this area. The first, in December 2001, was coordinated by Thompson, and received funding through the Program in Mathematics and Molecular Biology (PMMB) from the Burroughs Welcome Fund. (Thompson was a member of this inter-university program.) The second was in September 2003, coordinated by Monks and Kerr, and received funding from PMMB and from the UW NSF-funded VIGRE program. For each workshop, several students at Canadian Universities received funding through the Pacific Institute of Mathematical Sciences (PIMS). These two workshops were both highly successful, hosting 84 and 59 students (of whom 55 and 49 received funding), respectively. Students came predominantly from Universities and Colleges in Washington, Oregon, Idaho, Alaska, Utah, California, British Columbia and Alberta, but a few came from further afield.

In November 2005, the Third Seattle Biostatistics Symposium also showcased Biostatistical research and researchers in the area of Genetics and Genomics, and from 2006, with the move of Professor Bruce Weir to University of Washington, his internationally known Summer Institute in Statistical Genetics moved also, attracting graduate students and postdoctoral researchers both from UW and from around the world for three weeks in June 2006. Through the Statistical Genetics faculty and our colleagues in related disciplines, the University of Washington is becoming well known as a primary center of graduate education in Statistical Genetics. The Statistical Genetics Interdisciplinary Certificate is one component of UW's Statistical Genetics graduate education offerings.

G: Challenges for the future

With the huge advances in genetic and genomic technologies, the completion of the Human Genome Sequence, and the growth of the HapMap project and related projects, there has come also increasing recognition that Molecular Biologists, Population Geneticists, Computer Scientists, and Statistical Scientists must collaborate in understanding the newly available types and increasing amounts of genetic and genomic data. At UW since 1992, some major milestones were:

- 1) the formation of the Department of Molecular Biotechnology (MBT) in the early 1990s, the many genomic scientists it brought to Seattle, and that department's establishment of UW's NIH-funded Genome Training Grant;
- 2) the establishment of the UW Genome Center in the mid 1990's;
- 3) the development of Statistical Genetics courses in Statistics and Biostatistics in the late 1990's;
- 4) the huge growth of the Fred Hutchinson Cancer Research Center (FHCRC) towards genetics, genomics and bioinformatics, bringing again more internationally known quantitative genome scientists to Seattle, and providing incentive and opportunities for UW students, both during their studies and upon graduation; and last, but not least,
- 5) the formation of UW's Department of Genome Sciences in 2001, formed from the MBT and Genetics Departments, again bringing new internationally known faculty, new researchers and new students, and making UW a primary center of education and research in Genetics, Genome Sciences, and Computational Biology.

In this environment, there is no doubt that Statistical Genetics at the University of Washington will continue to grow. Our most recent successes are the arrival of Professor Bruce Weir as Chair of the Department of Biostatistics and Dr. Lon Cardon to the FHCRC. Dr. Weir headed the renowned Statistical Genetics program at North Carolina State University for many years, established the Bioinformatics Graduate Programs there, and is the developer and director of the internationally known Summer Institutes in Statistical Genetics. Dr. Cardon came to UW from the Wellcome Institute in Oxford, UK, and has been active in analysis of HapMap data, as well as other Human Genetics studies.

The Certificate program therefore faces a choice, on which we seek the opinion and advice of reviewers. It can remain as it is, an important, successful, but small, "zero-cost" complement to other Statistical Genetics degree training. Or it can seek to grow, but significant growth would require resources.

One way the Certificate program could grow would be to permit it to matriculate students. This possibility was raised by the Graduate School Council at the initiation of the program in 2000, but we did not wish to pursue it at that time. We have had several State and Federal (e.g. UW and

Northwest Fisheries) employees as non-matriculated students in our courses, who were disappointed to learn they could not officially receive a Certificate degree. These students have contributed much to the courses, and found that the courses contributed towards their employment success, but their non-matriculated status is a clear disincentive towards completing the full complement of courses. However, although numbers would not be large, this would not be a minor change. We would need an Admissions Committee and admissions administrative resources, as well resources in terms of faculty time.

Another area of potential growth is to separate Certificate curriculum from our PhD training core curriculum, and allow greater flexibility in the Certificate curriculum. Our core curriculum was primarily directed towards our PhD students, and is appropriate for them, but a wider Certificate curriculum would attract more students, both from Statistic and Biostatistics and from other UW graduate programs. For example, we could allow use of new UW Distance Learning courses in several areas of Statistical Genetics: these courses have been offered for several years through NCSU, but have transferred to UW with Professor Bruce Weir. While we would not wish to diminish the genetic and statistical prerequisites of our program, nor substitute for our core course sequence, there may be other existing UW courses which could serve our Certificate students well. However, these changes would also require significant resources, even if no new courses were to be offered. Faculty would have to determine what combinations of courses would meet our training goals, advise students on how best to meet those goals, and ensure satisfactory performance was achieved in an appropriate combination of courses. There might also be significant costs and disincentive to Statistics and Biostatistics graduate students, who, at the stage they take our courses, have often not determined whether they are Certificate or PhD pathway students. A shared and fixed curriculum has several advantages. Flexibility may be desirable, but the the cost is non-negligible.

We have a final request. The Statistical Genetics Interdisciplinary Certificate Program complements PhD education in Statistical Genetics within the Statistics and Biostatistics graduate programs. It is not of a size, nor has the resources, to make independent review practical. The next review should be coordinated with a program review of either the Statistics or Biostatistics department and degree programs.

Appendix 1: Members of the core Statistical Genetics Faculty

The following is an alphabetical list of the core Statistical Genetics faculty, and their Departments. Dates of former appointments (*) and of recent UW appointments are indicated: others have been active participants throughout the period of this review.

Faculty	Primary Dept	Joint/Adjunct Dept	Additional Info
Lon R. Cardon	FHCRC	Biostatistics	from 2006
Joseph Felsenstein	Genome Sciences	Biology, Statistics Computer Science & Engineering	
Phil H. Green	Genome Sciences	Computer Science & Engineering	
Kathleen F. Kerr	Biostatistics		
* Leonid Kruglyak	FHCRC	Genome Sciences	until 2004
Mary K. Kuhner	Genome Sciences		
* Stephanie A. Monks	Biostatistics		until 2004
* Matthew Stephens	Statistics	Genome Sciences	until 2006
John D. Storey	Biostatistics	Genome Sciences	from 2003
Elizabeth A. Thompson	Statistics	Biostatistics, Genome Sci.	
Bruce S. Weir	Biostatistics	Genome Sciences	from 2005
Ellen M. Wijsman	Medical Genetics	Biostatistics, Genome Sci.	

Appendix 2: Members of the Statistical Genetics Advisory Board

Ex officio members:	
Bruce Weir	Biostatistics (Chair), Genome Sciences
Peter Guttorp	Statistics (Chair), QERM
Other members:	
Arno Motulsky	Genome Sciences, Medicine
Maynard Olson	Genome Sciences, Medicine
Steve Self	Biostatistics, Fred Hutchinson Cancer Research Center
Barb Trask	Fred Hutchinson Cancer Research Center, UW Depts of Genome Sciences and Bioengineering

Appendix 3: Courses, Enrollments, and Evaluations

Quarter	Course	Instructor	Enrollment (for credit)	Evaluation (Median items 1-4)
Fall 1999	STAT/BIOST 550	Thompson	6	
Win 2000	STAT/BIOST 551	Monks	11	
Spr 2000	STAT/BIOST 552	Wijsman	5	4.95
Fall 2000	STAT/BIOST 550	Thompson	11	4.43
Win 2001	STAT/BIOST 551	Monks	7	4.20
Spr 2001	STAT/BIOST 552	Wijsman	4	5.00
Spr 2001	GENOME 562	Felsenstein	26	4.16
Fall 2001	STAT/BIOST 550	Thompson	17	4.5
Win 2002	STAT/BIOST 551	Henderson (visitor)	9	3.1
Win 2002	GENOME 540	Green	22	
Spr 2002	STAT/BIOST 552	Wijsman	8	4.9
Fall 2002	STAT/BIOST 550	Stephens	20	4.2
Win 2003	STAT/BIOST 551	Monks	10	4.6
Win 2003	GENOME 540	Green	16	
Spr 2003	STAT/BIOST 552	Wijsman	5	5.0
Spr 2003	GENOME 562	Felsenstein	27	4.4
Fall 2003	STAT/BIOST 550	Stephens	14	3.7
Win 2004	STAT/BIOST 551	Monks	9	4.4
Win 2004	GENOME 540	Green	20	4.7
Spr 2004	STAT/BIOST 552	Wijsman	7	4.1
Fall 2004	STAT/BIOST 550	Stephens	8	4.7
Win 2005	STAT/BIOST 551	Storey	8	
Win 2005	GENOME 540	Green	22	3.5
Spr 2005	STAT/BIOST 552	Wijsman	7	4.9
Spr 2005	GENOME 562	Felsenstein	29	4.3
Fall 2005	STAT/BIOST 550	Thompson	11	4.6
Win 2006	STAT/BIOST 551	Storey	7	
Win 2006	GENOME 540	Green	11	4.0
Spr 2006	STAT/BIOST 552	Wijsman	8	4.8

Notes:

- 1) in 1999-2000 STAT/BIOST 550-1-2 were offered under interim labels, STAT/BIOST 578C, 578A and BIOST 532 respectively.
- 2) GENOME 562 and GENOME 540 serve other students in addition to Statistical Genetics students.
- 3) Prior to 2002, GENOME 540 was offered as a section of MBT 599.

Enrollments in the Statistical Genetics Seminar: **BIOST 580B**

The Seminar has been coordinated by Professors Kerr, Monks, Stephens, Thompson, and Wijsman.

	Fall	Winter	Spring
1999-2000	7	6	11
2000-2001	11	14	11
2001-2002	19	15	16
2002-2003	15	10	13
2003-2004	17	14	12
2004-2005	14	13	14
2005-2006	11	13	13

Only enrollments for credit are tabulated: there are normally several additional participants.

Appendix 4: Certificates awarded

To date, seven Certificates have been awarded. Additionally eight students have completed PhDs in the StatGen pathways in Statistics or Biostatistics.

Quarter awarded	Department	Primary degree program
Spring 2003	Computer Science and Engineering	PhD
Spring 2003	Biostatistics	MS
Winter 2004	Biostatistics	PhD
Winter 2004	Biostatistics	PhD
Spring 2004	Biostatistics	MS
Spring 2004	Biostatistics	PhD
Spring 2005	Statistics	MS

Of our 3 Certificate alumni whose primary degree is an MS in Statistics or in Biostatistics, the first is now a staff biostatistician in the Psychiatry department at Massachusetts General Hospital in Boston. She is working on studies of the genetic basis of psychiatric disorders. The second was a PhD (1997) in molecular biology, who at SBRI for a few years before deciding to return for the M.S. in biostatistics. He is currently at Case-Western in the biostatistics/epidemiology department working on a genetic epidemiology project. Pending funding issues, he will be appointed as a staff research scientist. The third has a position as a staff programmer in the new bioinformatics unit at the FHCRC. He is seeking an industry position in bioinformatics, that will use both his computing skills and genomics training.

Those four whose primary degree program is a PhD, two have graduated and two are currently PhCand. Each does research in some area related to statistical genetics, computational genomics, or bioinformatics. In each case their StatGen Certificate program training complemented their primary degree program, and has contributed to their success in that program.

Appendix 5: Abbreviated Faculty Curriculum Vitae

Please see Appendix 1 for the Statistical Genetics faculty roster, their departments, and the dates of their participation in the program.

There follow the brief CVs of the following faculty:

Cardon, Lon R.
Felsenstein, Joseph
Green, Phil H.
Kerr, Kathleen F.
Kuhner, Mary K.
Monks, Stephanie A.
Stephens, Matthew
Storey, John D.
Thompson, Elizabeth A.
Weir, Bruce S.
Wijsman, Ellen M.

H: HEC Board Summary

- a) **The Statistical Genetics Certificate Program** is under the authority of the faculty of the Departments of Statistics and of Biostatistics. In practice, this authority is delegated to the core Statistical Genetics faculty who derive from the Departments of Statistics, Biostatistics, Genome Sciences and the Division of Medical Genetics.
- b) **The Department of Statistics** is in the College of Arts and Sciences, and the **Department of Biostatistics** is in the School of Public Health. The Department of Genome Sciences is in the School of Medicine, as also is the Division of Medical Genetics.
- c) **The degree offered** is an Interdisciplinary Graduate Certificate in Statistical Genetics.
- d) **The Certificate was established** in 2000 at the same time as the pathways in Statistical Genetics within the Ph D programs of Statistics and Biostatistics.
- e) **The Statistical Genetics field and its history at UW**

Statistical Genetics is the science of modeling and analysis of genetic data that derive from observations on plant, animal and human organisms. Genetics is the science of inheritance, and thus the modeling and analysis is of data on related individuals, whether these relationships be known or unknown. Many of the foundations of the discipline were laid in the 1930s by the three greats: R. A. Fisher, J. B. S. Haldane, and Sewall Wright. However, there have been successive waves of expansion:

from 1960 to 1975 with the increasing use of computational methods, data on extended pedigrees, and increasing numbers of genetic linkage findings,

from 1975 to 1990 with the advent of DNA markers bringing the potential for whole genome meiotic maps, and widescale genetic mapping, and

1990 to 2005 with new biotechnologies providing genomic data on DNA variation at the sequence level, and measurements of gene expression, enabling the resolution of more complex genetic traits.

Medical Genetics has been an active area at UW for over 50 years, through the leadership of Emeritus Professor Arno Motulsky. Statistical Genetics may be said to have started here in 1970, when Dr. Jurg Ott, then a research fellow in Medical Genetics working with Dr. Motulsky, wrote the first genetic linkage analysis computer program, LIPED. This program is still in use today, and Dr. Jurg Ott is a leading world expert in the area of human genetic linkage analysis. At that time, Dr. Joe Felsenstein had recently joined the Department of Genetics, working in Evolutionary and Population Genetics. Dr. Thompson joined the Statistics Department at the end of 1985, and Dr. Wijsman came to the Medical Genetics Division in the School of Medicine in Fall 1987. Together, Drs Thompson and Wijsman established the Statistical Genetics seminar, which is now the core seminar of our Statistical Genetics programs. Since 1988, Dr. Thompson has graduated 21 Ph.D. students in Statistics or in Biostatistics, all working in some area of Statistical Genetics.

The 1990s saw a huge growth both at UW and worldwide in research related to Statistical Genetics. At UW, we had the new Department of Molecular Biotechnology; a new UW Genome Center; a new NIH-funded Genome Training Grant; an NSF-funded graduate fellowship program in Mathematical Biology; the establishment of the Quantitative Ecology and Resource Management program out of the old Biomathematics program, which was the precursor to the graduate programs both in Statistics and in Biostatistics; the huge expansion at the FHCRC towards genetics, genomics and bioinformatics; and finally in 2001 the formation of the new UW Genome Sciences Department. Each stage brought new faculty, new research associates, and new students.

Over many years, there was a widely recognized scarcity of statistical scientists to meet the demands of the new genetic and genomic technologies for methods of analysis of the ever-expanding data. By 1999, it was clear that the Departments of Statistics and Biostatistics should take a lead in providing Statistical Genetic training opportunities for quantitative students at UW. Each Department committed significant faculty resources; Dr. Stephanie Monks and subsequently Dr. Kathleen Kerr joined the Biostatistics faculty, and Dr. Matthew Stephens was recruited to the Statistics Department. New courses were developed, building on existing offerings, and both the Ph.D. pathways and the Certificate program became officially established. The Statistical Genetics core faculty now number nine, and include internationally recognized senior leaders in the field in Statistics, Biostatistics, Medical Genetics, and Genome Sciences.

f) There is a clear continuing need for the Statistical Genetics Certificate program.

The demand for statistical geneticists to collaborate in genetic epidemiological, population genetic, and related research fields does not abate. Even though more students are now trained, with the establishment of new programs at several leading US Universities, the demand grows even faster with ever increasing amounts and changing types of genetic and genomic data. While the numbers of students completing the Certificate program is small, the program is an essential complement to Ph.D training in Statistical Genetics, Mathematical Biology, Quantitative Ecology, and Computational Molecular Biology. It is a part of the glue that holds these interdisciplinary programs together in coherent collaboration, providing a better education to all students in these areas. It brings a diversity of students to our Statistics and Biostatistics classes, benefiting both the students from more mathematical backgrounds and those whose primary training is in the biological or medical sciences.

g) Assessment information relating to student learning outcomes:

Although few students complete all the courses of the Certificate curriculum, the numbers in the core course sequence STAT/BIOST 550-1-2 remains steady and healthy at about 10-12 each year. The courses have been highly rated by students, and many students have commented how the courses have helped them in their employment or in their primary degree program.

Our three Certificate alumni whose primary degree program was an MS degree, and additionally several other core-sequence students who did not complete the Certificate program, are working as staff scientists on research projects in Genetic Epidemiology or in Bioinformatics. It is their UW Statistical Genetics training that has equipped them to be successful in these positions.

Our four Certificate alumni whose primary degree was a Ph.D. program all completed, or are completing, a PhD in an area related to Statistical Genetics or Computational Molecular Biology. They were attracted to the Certificate program because of its relationship to their research interests. Conversely the Certificate program has contributed to their Ph.D. research.

h) Numbers of Certificates awarded in each of the last three years:

In 2003, 2004, 2005, there were 2, 4 and 1 Certificate awarded, respectively.

i) Plans to improve quality and effectiveness:

The Departments of Statistics and Biostatistics, and our colleagues in Medical Genetics and in Genome Sciences, are committed to the further development of research and education in Statistical Genetics at University of Washington. Immediate plans include new faculty, with new research areas, and new PhD training grant applications. However, plans specific to the Certificate program are limited, and are dependent on resources specific to that program being made available.

Currently the Certificate program does not matriculate students, and the Certificate curriculum is coincident with the core curriculum of the Statistical Genetics PhD pathways. The Certificate program could better serve employees in research positions in State or Federal agencies, including UW, if it could matriculate such students. A more effective Certificate curriculum might include more practical training in analysis methods, and less emphasis on methodological foundations. A more flexible curriculum could serve a wider variety of students, without impacting the quality of the program.

Summary:

The Interdisciplinary Certificate program is a complement to the broad diversity of UW graduate education opportunities in quantitative biology, and to the Statistical Genetics PhD pathways in Statistics and Biostatistics in particular. It is fully supported by the Statistics and Biostatistics departments who bear the primary costs of faculty teaching resources. There are no other costs, nor are any courses offered that serve only the Certificate students. Thus it is a zero-cost, much-benefit, activity.

Please note also our request, that subsequent reviews of the Interdisciplinary Certificate program be coordinated with review of either the Statistics or Biostatistics department and programs. The Certificate program alone has neither the size nor the resources for separate review to be practical.