Establish an Academic Program
Bachelor of Science in Genomic Medicine (BS-GM) in the
College of Science and Technology (CST)

Executive Summary
The College of Science and Technology (CST) is proposing a new Bachelor of Science (BS) in Genomic Medicine. This 123 credit program is designed to attract and serve the next generation of researchers and professionals interested in careers at the interface of biology and human health. Graduates will have gained a foundation in the life sciences that emphasizes the medical relevance of genomics, evolutionary biology, and informatics, making them better prepared than most peers for entry into the medical school and STEM research careers in Medicine. This program will also compensate for the growing clinical emphasis in medical colleges, and consequent lack of medical school emphasis on many foundational fields, by providing students with a solid basis for understanding and working with modern biological data. By making future medical professionals and biomedical researchers conversant in these domains in their formative years, through a well-prescribed curriculum, we will train the next cadre of graduates at the vanguard of the Medicine revolution. Also, the broad-based professional education, imparted by BS-GM, will make graduates better prepared for gainful employment in scientific research positions as well as acceptance to medical and STEM graduate programs.

The BS-GM will be offered beginning Fall 2019.

Details

1. What, if any, disciplinary or professional trends influenced this proposal?
   a. Scientific innovations and high-throughput technologies have enabled biologists to amass datasets of unprecedented size and scope. The new biological data are revealing the intricacies of life and health to a depth and breadth not previously imagined. At the center of this remarkable transformation is the study of the blueprint of life, the genome, which is the basis of many human diseases. Information from thousands, and soon to be millions, of genomes is revealing the underlying basis of human development and yielding profound insights into the causes of many diseases. When paired with other high-throughput “omics” technologies, these massive multiscale datasets will enable the harnessing of knowledge from molecular biology and information on diseases for healthier individuals. These realizations have founded a new discipline at the intersection of genomics, disease, evolution, and informatics (Genomic
b. Trends at Temple, over the last four years, have also encouraged us to
develop the new program. Electives such as Genomics in Medicine (BIOL
3111; >60 students), Genomic Evolutionary Medicine (BIOL 3112; >100
students), and Evolution (BIOL 3101; >100 students) have been chosen by
a large number of students at Temple in the most recent academic year
(2018-2019). Interest in genomic medicine courses (BIOL 3111 and 3112)
has grown by 50% each year over the last three years. The growth of
interest in the Undergraduate Genome Medicine Certificate program is also
evidence in favor of establishing a full-fledged degree program because the
certificate program requires extra course load and does not permit us to
direct a holistic curriculum that students interested in Genomic Medicine
need.

2. How will our program compare to the top programs in this discipline?
   a. We are proposing a first-of-its-kind undergraduate degree program in
      Genomic Medicine (BS-GM) to prepare the next generation of researchers
      and professionals interested in careers at the interface of biology and
      human health. Students will gain a foundation in the genomic and
      evolutionary fundamentals of biological processes and will do so while
      learning about the biological bases of medical science. Students will also
      gain valuable experience in genomic and medical informatics, which will
      make them better prepared than their peers for entry into the medical school
      and STEM research careers in Medicine.
   b. Although BS-GM cannot be compared directly to existing programs, we did
      assess demand for graduates in this area by reaching out to admissions
      personnel in medical colleges, and people highly placed in biotechnology
      companies. Dr. Glenn Gerhard1, who helped develop this proposal, said
      students with this major would be highly attractive to medical schools.
      Similarly, Dr. Claudia Kasales2, a member of the Penn State College of
      Medicine Admissions Committee, said that "'genomic medicine' would look
      great on a medical school application." Turning to leaders in biotech and
      informatics Dr. Deanne Taylor3 said that “I think the major is a fine idea. I
      base this on the uniqueness of the field you will be serving. Also I feel you
      have a layer of safety in that the requirements of the MCAT test are
      published and also have the reqs of most med schools available to build the

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2 Professor of Radiology, Penn State Hershey Breast Center, Department of Radiology, Penn State Health
3 Director of Bioinformatics, Biomedical and Health Informatics, Children’s Hospital of Philadelphia
major around.” Dr. Danielle Greenawalt⁴ said that “We are always looking for people that have an understanding of the clinical context of the data they are analyzing …I do believe the Genomic Medicine major would distinguish students, as did others I received feedback from.” Dr. Hitomi Ohkawa⁵ said “At the highest level, given what’s happening in the increasingly digital medical & healthcare environment and explosion of available data, programs/majors on ‘Genomic Medicine’ would be undoubtedly of great interest to the industry, be it manufacturers (Pharma/Biotech where I have decades of experience) or providers (doctors/healthcare professionals),” Finally Dr. Louise Showe⁶ shared that “… this new major would fill a niche that is growing.”

c. This program will uniquely prepare students for the medical school in two critical ways. First, the program will train students in areas that are of growing importance in medicine, including genomics and informatics, and will do so in ways that explicitly provide a health-related context. Secondly, by focusing their biological education on conceptual areas that are fundamental to biological processes, including genomics and evolution, the program will help address the growing shift in MD curricula towards clinical training and away from basic scientific training. By making future medical professionals and biomedical researchers conversant in all of these domains early in their formative years, the next cadre of Temple-graduates will be at the vanguard of the Genomic Medicine revolution.

3. How is the proposed program consistent with regional and national competitors?

a. A thorough survey of undergraduate degree offerings in the life sciences by Universities/Colleges in the Philadelphia area revealed that none offer a degree comparable to BS-GM. This was also true for institutions outside Philadelphia. That is, no other regional or national competitors offer an undergraduate degree program in Genomic Medicine. However, there are plenty of specialized and interdisciplinary undergraduate degree programs in life sciences, including those in CST at Temple (e.g., Neuroscience and Biochemistry). Both of these specialized majors have more than 400 students in total, and it is expected that BS-GM enrollment will also be substantial.

b. Specialized majors fulfill an essential role for students who can articulate to some extent their career goals and who have knowledge of the opportunities in their areas of interest. Such students tend to be stronger on

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⁵ President and Principal Consultant, HTSB Consulting LLC
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average than students with less-focused interests, and Temple University is currently successful in attracting large numbers of them to its many specialized majors. The proposed BS-GM will fulfill this role for the many prospective students who seek a medical career and who have some understanding of the importance of genome science in human health. Even though these students may be in the minority, they could come from all over the world and will be among the most forward-looking and motivated students.

c. We firmly believe that a separate undergraduate major, rather than a track in an existing major (e.g., Biology), is necessary for *Genomic Medicine*. This is for recruitment and programmatic reasons. By having a distinct and unique major, we will be able to communicate Temple's program and commitment to *Genomic Medicine* unambiguously to prospective students. The new major will be a great recruitment tool domestically and internationally. In our opinion, establishment of a track is not effective in recruiting the student cohort we wish to attract to Temple. Recent success of the new Health Professions undergraduate degree program in the College of Public Health can be taken as evidence for this way of thinking. The number of incoming undergraduates has doubled after the first year from 127 to 252, and the program only began two years ago. Our BS-GM will provide a more holistic and stronger program for such students who are interested in the scientific aspects of the health profession.

d. Programmatically, some core requirements of BS-Biology need to give way to core needs of BS-GM, as the latter needs to accommodate multiple core requirements (e.g., *Evolution*, *Genomic Evolutionary Medicine*, *Genomic Foundations of Medicine*, and *Pathophysiology of Genomic Medicine*). Also, we wish to offer these courses to students by their junior year, so they have the maximum information possible before they apply to the medical school or select their next professional career. For this reason, BS-GM curriculum places introductory biology courses (BIOL 1111 and 2112) in the first year and will require students to take *Genetics* in their second year, which Biology majors frequently delay taking until much later.

4. Where relevant, the relationship of the proposed program to other programs in the department, college, and University
   a. The proposed BS-GM degree program complements the existing Biology undergraduate degree program offered by the Department of Biology in CST. However, BS-GM is distinct in that it is sharply focused on preparing graduates who wish to pursue the next generation of medicine-related careers requiring strong familiarity in genomics, medicine, evolution, and informatics. We intend
to develop a student cohort that follows a well-prescribed four-year program not only to be better prepared to enter medical school but also more directly employable in research and other industries that demand expertise in genomics, analytics, and medicine.

b. BS-GM program will fulfill all the pre-health requirements for students interested in pursuing health professions, but the proposed program will uniquely forge the connection of genomics and evolution to medicine and provide new introductory and advanced courses in Genomic Medicine. Providing a robust genomics and evolution foundation will transform learning and outcomes for many, and will set standards for the future. This combination of knowledge and skills fills a need for health professionals and researchers and will provide greater employment and higher education opportunities for our graduates.

5. Curriculum-Include a semester-by-semester curriculum grid (advising worksheet)
   a. Provided in the appendix.

6. Unique characteristics of the program, type, and level of instruction, new courses to be developed or syllabi of existing courses, sequencing of courses, concentrations or tracks, and other requirements such as comprehensive exams, theses, practica, non-standard grading scales, auditions, portfolio review, etc.
   a. We will propose two new core courses that will primarily cover the genes and mutations associated with the major genetic diseases of adults (Genomic Foundations of Medicine) and the cellular and physiological effects of disease genes and mutations (Pathophysiology of Genomic Medicine). The first course will be taken by BS-GM in the sophomore year and the second course will be offered in their junior year.
   b. Many existing elective courses will be part of the core requirements in BS-GM, including BIOL 3101 (Evolution) and BIOL 3112 (Genomic Evolutionary Medicine), with a large number of existing courses serving as electives.
   c. Sequencing of introductory biology and genetics courses will be such that the BS-GM students will take introductory biology courses (BIOL 1111 and 2112) in their freshman year and Genetics (BIOL 2296) in the sophomore year. This change will be necessary for BS-GM students to select advanced electives related to genomics and Medicine early on and make informed choices about their future medical and research specialization. Students transferring into the program after arriving at Temple will also be provided with a path (Plan-B in the academic plan) to complete all the degree requirements within the four years.

7. Description of how courses will be scheduled to ensure that students will be able to complete the course of study within a reasonable time frame. Time limits
for completion may vary but should be no longer than 4 years if the program will be advertised as a four-year undergraduate program.

a. The program is designed and courses scheduled to ensure completion of the degree in 4 years, as seen in the course grid above.

8. List campus(es) where the program will be offered or indicate if the program will be delivered at an off-campus, non-Temple location.

a. All the courses will be delivered at the main campus, with two of the courses possibly offered at the Temple University Health Sciences campus that is within a short distance of the main campus.

9. Discussion of availability of faculty to support the program, including information about the hiring of new staff and faculty and/or reassignments of existing personnel (instructional deployment)

a. CST has developed strengths in evolutionary genomics and informatics over the last five years. Many faculty members in CST and Temple-at-large are studying genome function in humans and other model species; and mapping diseases and traits to genomes through comparative analysis of species and populations. A majority of these efforts are currently in CST’s Department of Biology and the Temple University School of Medicine. Faculty members from both of these units have been involved in developing BS-GM and will be teaching many of the biology and genomics-related core courses and electives.

10. Requirements for admission to the program plans for recruiting students, the projection of the availability of qualified students and demand for the program and anticipated employment or advanced study opportunities for graduates of the program.

a. There will be no special requirements for admission to the program, except that the enrollment in the required course *Genomic Foundations of Medicine* (sophomore year) will require a B or better in the prerequisites (BIO 1111 or BIOL 2112). Also, enrollment in the required *Pathophysiology of Genomic Medicine* will require a B or better in the prerequisite *Genomic Foundations of Medicine*.

b. We plan to reach prospective students in the US and internationally through extensive advertisements online and physically. Our focus will be on reaching prospective students who incline to pursue a specialized degree in life sciences that have a strong professional focus and future. Given the growing recognition of the role of DNA in understanding our health and our ancestry, we believe that time is right to embark on offering specialized
undergraduate degrees that target genomics and medicine while providing all the benefits offered by a biology degree at Temple. Only through innovative and professional programs can we expand (or even maintain) our current enrollment numbers in the face of shrinking numbers of high school graduates in the US.

c. We expect the student pool to consist of domestic and foreign applicants and will include students who have an interest in DNA-based life sciences professions. Admittance to the program will not be restricted, but the ability to complete the major successfully will require that the above conditions are met.

d. We will advertise on Google via context-sensitive advertisements and use the Liaison software to inform prospective students. We also plan to make connections with international recruiters, who advise high school students throughout the world. For all these efforts, we will develop strong online presence.

11. Describe any special tuition or fees to be charged.
   a. None.

12. Projected enrollments, student credit hours, and degrees to be granted over each of the first five years, by campus or site.
   a. We anticipate that initially, 25 new students will enroll in BS-GM and that this number will grow by ~20% each year.
   b. Total student cohort pursuing BS-GM will be from 50 to 200 within five years, with 50 new students enrolling in BS-GM every year after that.
   c. Of course, undergraduates with other declared majors may opt to pursue BS-GM after their arrival at Temple. They will be added to the cohort counts above.

13. The short- and long-term effects on other University programs, including increased or decreased demand for courses or services, loss or addition of students, student aid, library, or computing resources, etc.
   a. The new courses will be taught in the regular classroom instruction. None of the current elective courses that will become core in BS-GM require laboratories if there is an increased demand for these courses then they will be accommodated by increasing the class size, offering additional sections, and by giving priority to BS-GM students during the early registration period.
   b. Most importantly, we do not anticipate needing more laboratory space for introductory courses due to new BS-GM students, because, even though the enrollment in the Biology undergraduate program is high (1400 students), there
has been some decrease recently in the number of students enrolling in introductory biology laboratories. This decline is consistent with national trends and has created spaces to be filled by the new BS-GM students. The same will be true for many other core courses taught in the lecture-only classrooms.

14. An analysis of the impact on space resources, including office, laboratory, and classroom space, must be included.
   a. We do not expect to need any additional resources.

15. Overview of the impact such as Net changes in tuition revenue and resulting instructional and non-instructional personnel and employee benefits per the enrollment-based budget model. Indicate if any one-time or ongoing investments will be requested. A summary of financial increases, savings, or reallocations. Non-financial requirements or savings in areas such as space, facilities, or equipment
   a. This forecast will be done in collaboration with the CST Dean’s office.

16. Assessment - What are the program goals (student learning outcomes)? How will student learning be evaluated? What will be considered evidence of student learning and success?
   a. This will be done at the time of the submission of the white paper.

17. When will change take place (fall or spring semester, year)
   a. Fall, 2019

18. If applicable, include a full description of the impact on enrolled students, describing options for transfer to the new program, time limits for completion and other procedures.
   a. For science students, we have prepared a detailed academic plan on how to fulfill all the requirements of BS-GM within a four-year degree program. We refer to it as Plan B, as compared to Plan A for students who declare BS-GM major before the start of their freshman year (see academic plan).

19. List any collegial committees that reviewed, endorsed or approved the proposal
   a. Ongoing.

20. Discuss how the proposal relates to visiting team recommendations from the most recent periodic program review
   a. A recent septennial review of the Biology department noted that the department is among the top in research at the interface of genomics, evolution, and
population genetics.

21. Describe any implications for accreditation
   a. NONE

22. Steering Committee
   • Sudhir Kumar, Biology, CST
   • Jody Hey, Biology, CST
   • Glenn Gerhard, Temple University School of Medicine
   • Shohreh Amini, Biology, CST
   • Anna Moore, Biology, CST
   • Antonio Giordano, Biology, CST
   • Seema Freer, Biology, CST