Master of Science in Translational Biotechnology

MS Translational Biotechnology
Keck School of Medicine of USC
University of Southern California
Harlyne J. Norris Cancer Research Tower
1450 Biggy Street, NRT 2506A
Los Angeles, CA 90033

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http://dtg.usc.edu/education/translational_biotechnology

Curriculum Summary
Total requirement: 28 units

* denotes courses designed specifically for the Translational Biotechnology Program

Core Lecture Courses (Required, 12 units)

*TRGN 536 Biotechnology Primer (4 units)
*TRGN 537 Pathway and Target Discovery (4 units)
*TRGN 538 Seminar in Translational Biotechnology (2 units)
*TRGN 543 Biotechnology Entrepreneurship and Commercialization I (2 units)

Experiential Learning (Required, 7 units)

*TRGN 539 Translational Biotechnology Practicum (2 - 4 units/per semester, max. 4)
*TRGN 540 Translational Biotechnology Capstone Preparation (1 unit)
*TRGN 541Translational Biotechnology Capstone Defense (2 units)

Electives (at least 9 units)

*TRGN 542 Biotechnology-based Therapeutics (2 units)
*TRGN 544 Biotechnology Entrepreneurship and Commercialization II (2 units)
*TRGN 545 Exploring Chemical and Biological Therapeutic Modalities (2 units)
*TRGN 546 Biotechnology Intellectual Property, Regulatory, and Corporate Law (2 units)
*TRGN 550 Communicating Science - writing (1 unit)
*TRGN 551 Communicating Science – speaking (1 unit)
*TRGN 590 Directed Research (1 – 12 units, max. 4 for degree requirements)
*TRGN 599 Selective Topics
TRGN 510 Basic Foundations in Translational Biomedical Informatics (4 units)
TRGN 514 Introduction to Human Genomic Analysis Methods (4 units)
TRGN 515 Advanced Human Genomic Analysis Methods (4 units)
TRGN 516 Translational Genomics, Applied Databases and Datastructures (4 units)
TRGN 524 Applications of Genomic Technology in Biomedical Research I (4 units)
TRGN 525 Applications of Genomic Technology in Biomedical Research II (4 units)
TRGN 526 Clinical Bioinformatics in Genomic Testing (2 units)
TRGN 527 Applied Data Science and Bioinformatics (4 units)
BAEP 551 Introduction to New Ventures (3 units)
BAEP 552 Cases in Feasibility Analysis (3 units)
BAEP 561 Entrepreneurship in Innovative Industries: Life Sciences (1.5 units)
BAEP 563 Corporate Entrepreneurship (3 units)
INTD 504 Molecular Biology of Cancer (4 units)
INTD 531 Cell Biology (4 units)
INTD 572 Systems Physiology and Disease I (4 units)
INTD 573 Systems Physiology and Disease II (4 units)

Core Lecture Courses (Required, 12 units)

Students with strong background in biotechnology may substitute TRGN 536 with another appropriate course, with permission of the program director. A minimum grade point average of 3.0 on all core courses is required.

TRGN 536 Biotechnology Primer (4 units)

Modern biotechnology utilizes cellular and biomolecular processes to develop technologies and products that help improve lives and the health of our planet. For over a half century, biotechnology drives the development and production of new vaccines, therapeutic products and procedures to combat serious illnesses and everyday threats confronting the developed and developing world. Biotechnology also enables the improvement of global population's wellbeing with products and procedures that enhance crop insect resistance, increase yield, and facilitate more environmentally sustainable farming practices. Combining these efforts with those in developing biofuel, biotechnology field seeks to Heal the World, Fuel the World, and Feed the World.

However, even with more than 250 biotechnology-based therapeutic products and vaccines available to the world's population, scientists have yet only uncovered a small fraction of potential uses of biotechnology.

This course provides in depth examinations of classical and novel techniques currently used to explore and manipulate gene function. Topics include characterization of biochemical activities of gene products in vitro and in heterologous cells, investigation of gene function in model genetic organisms and in humans, and manipulations of genetic materials via cloning, mutagenesis and transgenesis.

TRGN 537 Pathway and Target Discovery (4 units)

To discover a therapy and take it from bench to bedside is an arduous and multidisciplinary undertaking. Recent developments in science and technology, as well as changes in economic landscapes and government regulations have produced an exciting and complex field in therapy discovery and development. This course is intended for bio scientists who are interested in the process of applying scientific knowledge to discover new targets and pathways for novel biologics and therapeutic treatments. The molecular basis of human diseases will be discussed with an emphasis on novel therapeutic approaches. The course will include a combination of lectures and discussion of original research articles.

TRGN 538 Seminar in Translational Biotechnology (2 units)

The field of biotechnology is advancing rapidly and expanding into diverse disciplines. This course is designed for students enrolled in the master's programs within Keck School of Medicine. Seminars are given by outside speakers who are in the forefront of the field. This course seeks to provide the most updated view of various subspecialties in biotechnology. This seminar series include discussions in biotechnology, entrepreneurship, law, and industrial-scale production which are of particular interests to many bioscience students but are rare in traditional academic bioscience seminars.

The seminar by the outside speakers will be open to all members of the school. This will add an exciting new dimension for intellectual consideration within the school. Following each seminar, the speaker will lead discussions with only students registered in the course. A format such as this will provide a more relaxed atmosphere for discussion. Without faculty and other more advanced seminar attendants, master's students can feel freer to ask questions and participate in discussions.

TRGN 543 Biotechnology Entrepreneurship and Commercialization I (2 units)

This is the first of two courses that examine the entrepreneurial process in biotechnology from idea generation through economic viability. Biotechnology companies are unique in that they often need a decades-long period of incubation prior to becoming self-sustaining. Topics of this course include an overview of the global biotechnology industry, idea generation, business plan formulation, intellectual property protection, funding, personnel management including board composition, regulatory body interaction and company exits.

This course is directed towards advanced students in biosciences or bioengineering. By starting their own virtual "BEEnopoly" biotech company, students will be introduced to the steps needed to start and nurture a biotechnology company in the healthcare realm, and gain an ability to assess the health of potential collaborators, partners or employers.

Experiential Learning (Required, 7 units)

Experiential learning includes a total of 4 units of TRGN 539 plus two Capstone courses. This program does not require a thesis. Instead, students are required to defend their program capstone through TRGN 540 and 541, which include practicum conclusion, reflective narratives, and portfolio presentation.

TRGN 539 Translational Biotechnology Practicum (2 – 4 units/semester, max. 4)

Students enrolled in the Translational Biotechnology program are required to engage in a practical project to be conducted in research laboratories or corporate environment under the supervision of USC faculty and corporate mentors/liaisons. Students, under the advisement from program director and faculty, can choose to work in academic or industry setting, locally or globally.

This course is a practical experiential training that will integrate elements of the Translational Biotechnology curriculum into an applied project, giving students hands-on experience in the biomedical, biotechnology and pharmaceutical fields. Students may work on a significant project related to their professional aspiration. The student and the mentor determine the nature and extent of this independent study. In some arrangement, the student may be assigned to work with an associate member of the mentor's team, who is in turn supervised by the mentor. The mentor is responsible for mentoring and evaluating the student's progress and performance.

A Translational Biotechnology faculty will coordinate this course. The coordinator is responsible for determining the appropriateness of the project in meeting degree requirements. The coordinator also serves as a liaison between the Translational Biotechnology program and the mentor.

TRGN 540 Translational Biotechnology Capstone Preparation (1 unit)

This course is designed for students to establish an overall framework and to develop understandings, skills, and outlooks to conduct the required Translational Biotechnology capstone project.

Students will develop a master plan and schedule for each semester and for their tenure in the Translational Biotechnology program. This plan will serve as the basis for monitoring and assessment of each student's overall academic and professional progress.

Students will engage in a portfolio building process and submit periodic assignments integrating what they have learned across multiple course works. These reflective assignments, combined with their Translational Biotechnology Practicum results (TRGN 539), will be assembled into a final portfolio, submitted and presented in a symposium in later semester (TRGN 541 Translational Biotechnology Capstone Defense)

TRGN 541 Translational Biotechnology Capstone Defense (2 units)

In this course, students finalize and defend their program capstone which includes practicum conclusion, reflective narratives, and portfolio presentation.

Throughout the Translational Biotechnology program, students will engage in a portfolio building process and submit periodic assignments intergrading what they have learned across multiple course works. These reflective assignments, combined with their practicum results, will be assembled into a final portfolio, synthesized by the student and submitted and presented in a symposium to an open audience including their peers, faculty of the Translational Biotechnology program, members of Keck School of Medicine, and invited guests from biotechnology and pharmaceutical industries. This course provides the culminating, integrative curricular experience for students enrolled in the Translational Biotechnology program.

This course is graded NC/CR, with full credit on submission, presenting, and successful defending of their program capstone report.

Electives (At least 9 units)

At least 4 units must be from TRGN. No more than 4 units of TRGN 590 may be used to fulfill degree requirements.

TRGN 542 Biotechnology-based Therapeutics (2 units)

Modern biotechnology utilizes cellular and biomolecular processes to develop technologies and products that help improve lives and the health of our planet. For over a half century, biotechnology drives the development and production of new vaccines, therapeutic products and procedures to combat serious illnesses and everyday threats confronting the developed and developing world. Biotechnology also enables the improvement of global population's wellbeing with products and procedures that enhance crop insect resistance, increase yield, and facilitate more environmentally sustainable farming practices. Combining these efforts with those in agribiotech and biofuel, biotechnology field seeks to Heal the World, Fuel the World, and Feed the World.

However, even with more than 250 biotechnology-based therapeutic products and vaccines available to the world's population, scientists have yet only uncovered a small fraction of potential uses of biotechnology.

Building on foundations developed in TRGN 536 Biotechnology Primer, this course covers advanced biotechnology principles and applications. Topics include newest generation sequencing, expression analysis, protein and nucleic acid-based modifications and interventions. Emphasis will be placed on applications that lead to or assist in therapy discovery.

TRGN 544 Biotechnology Entrepreneurship and Commercialization II (2 units)

This is the second, and advanced, sequence of the two courses that examine the entrepreneurial process in biotechnology from idea generation through economic viability. Biotechnology companies are unique in that they often need a decades-long period of incubation prior to becoming self-sustaining. Topics of this course include an in-depth analysis of the global biotechnology industry, idea generation, business plan formulation, intellectual property protection, funding, personnel management including board composition, regulatory body interaction and company exits.

This course builds on foundation that students established from TRGN 543 Biotechnology Entrepreneurship and Commercialization I. It uses a similar structure as TRGN 543 while diving deeper for each topic. Students will continue to grow their own virtual "BEEnopoly" biotech company that they started in the previous course.

TRGN 545 Exploring Chemical and Biological Therapeutic Modalities (2 units)

This course surveys the variety of chemical and biological modalities for therapeutic interventions. It covers small molecules, therapeutic proteins, monoclonal antibodies, engineered multi-specific antibodies, cell-based immunotherapies, stem cell applications, viral therapy and microbiome-based therapeutics. This course covers both classic and new modalities. It discusses critical processes that shepherd our understanding in basic science into practical use in the clinic from proof of concept through practical considerations in production and usage. Emphasis will be placed on the selection, development, and optimization of appropriate modalities to target specific key defects in diseases.

This course is suitable for those who have basic background in drug discovery process and moderate exposure in variety of therapeutic options, and are interested in the considerations of turning molecules into drugs and turning cells into therapeutics.

TRGN 546 Biotechnology Intellectual Property, Regulatory, and Corporate Law (2 units)

The term "biotechnology law" is used here to mean a collection of distinct areas of law that play a prominent role in the biopharmaceutical and diagnostic industries. There are many legal disciplines having at least some nexus with this industry, and they collectively include diverse legal specialties. This course will introduce students to these interrelated fields of intellectual property law, regulatory law, securities law, healthcare law, corporate law, and M&A law as they are applied to the biopharmaceutical and diagnostic device sectors. Patents and related agreements have become critical resources for universities and research institutes, and commercial entities ranging from early stage startup companies to large, publicly-traded companies expend vast resources to navigate the various rules and laws pertaining to product intellectual property, product development, clinical trials, FDA approval, financing operations, post market compliance, and commercial exits. The course will present core concepts in a way that permits students to apply them throughout their corporate, academic and government careers.

Rather than emphasizing the detailed study of statutes and case law, this course will impart an understanding of key US legal concepts, and their underlying policies, through guided discussion of practical examples relevant to the medical device, pharmaceutical, and biotechnology industries. This course aims to focus lectures and discussions on the spirit and application of the law within academic and commercial contexts, rather than the letter of the law.

TRGN 550 Communicating Science: Writing (1 unit)

This course surveys the variety of written communication modalities for transmission of scientific information in the workplace. It covers internal and external communication skills necessary for successful careers in biomedical, healthcare, and related industries. This course covers both traditional and novel communication modalities. It discusses essential processes for the accurate transmission of scientific data to diverse stakeholders both within the enterprise and external to the scientific endeavor. Emphasis will be placed on the selection of key communication points, development of processes to package data for accurate dissemination, and optimization of communication strategies to ensure data is conveyed accurately and effectively.

TRGN 551 Communicating Science: Speaking (1 unit)

This course surveys the variety of communication modalities for verbal transmission of scientific information in the workplace. It covers internal and external communication skills necessary for successful careers in biomedical, healthcare, and related industries. This course covers both traditional and novel communication modalities. It discusses essential processes for the accurate transmission of scientific information to diverse stakeholders both within the enterprise and external to the scientific endeavor. Emphasis will be placed on the selection of key communication points, development of processes to package data for accurate dissemination, and optimization of spoken communication strategies to ensure data is conveyed accurately and effectively.

TRGN 590 Directed Research (1 – 12 units)

This course will offer opportunity for students enrolled in MS in Translational Biotechnology to conduct research relevant to their program of study beyond what is required for program practicum. Max. 4 can be used to fulfill degree requirements.

The program also incorporates additional 8 elective choices from the Department of Translational Genomics, 4 electives from KSOM's Interdepartmental repertoire for those seeking more advanced basic science coverage, and 4 electives from the USC Marshall School of Business that explore and explain entrepreneurship beyond biotechnology sector. Students have additional options to select other relevant courses from the University with advisors' approval.

TRGN 510 Basic Foundations in Translational Biomedical Informatics (4 units)

The objective of this course is to train individuals with strong backgrounds in biological or medical fields the analytical and computational skills for analysis of biomedical data. It will introduce students to tools and concepts that will be instrumental throughout the program. Particular focus will be on applicability to the healthcare field and training

students to effectively implement, develop, and design bioinformatic solutions within different healthcare applications from prototyping to production. They will be trained and have an understanding of modern molecular data with a major emphasis on data analysis and data processing associated with next-generation sequencing data.

TRGN 514 Introduction to Human Genomic Analysis Methods (4 units)

This course is part of a two-course series and complements courses offered as part of masters in translational biomedical informatics offered within the Keck School of Medicine. It is targeting students without strong computational or analytical experience, but who have experience with advanced biological concepts.

This course focuses first on public databases and their utility to bioinformaticians in relation to studying human disease as an overview with the understanding that deeper use of these as APIs is reserved for the following semester. In the mid part of the course, we focus on applied analysis using microarray data from DNA and RNA, and conceptually how different analysis strategies are used. While we provide a high-level overview of analysis strategies so that students can understand the types of analysis that are traditionally used to approach studies of human disease. This course is not intended to provide the statistical expertise to interpret these, but rather the pragmatic capabilities to be able to apply these methodologies.

TRGN 515 Advanced Human Genomic Analysis Methods (4 units)

This course will continue building from the prior TRGN 514 course. This course covers more advanced concepts that are used in genomics analysis. It will build on the topics that were introduced in the previous course as well as introduce several new concepts. Analysis of Next Generation Sequencing will be covered with the focus on RNA sequencing analysis methods and epigenetic sequencing. RNA sequencing best practice analysis workflows will include alignment, fusion detection, and differential expression. Epigenetic sequencing will cover the analysis and interpretation of several methods. Finally, the course will touch on protein modelling.

TRGN 516 Translational Genomics, Applied Databases and Datastructures (4 units)

The course will consist of two primary areas: understanding how to work with databases and understanding the regulatory environment around their use. A major part of this course will be on applied projects where in teams students will be asked to use a case-study based approach to identify appropriate datasets, use analytic tools to analyze data, evaluating hypotheses, and interpret results.

The course will equip the student with modern databasing NoSQL, SQL frameworks, the development and communication of results from tools such as R through web-apps. Through this course, students will learn on applied datasets how to construct advanced

human annotation pipelines for managing and integrating biomedical data particularly through use in pipelines.

TRGN 524 Applications of Genomic Technology in Biomedical Research I (4 units)

This is the first of two courses with the objective to train and provide individuals with strong backgrounds and interests in biological or medical sciences the theoretical and applied knowledge of modern day biotechnology. It will introduce students to tools and applications that will be instrumental throughout the Translational Biomedical Informatics and Translational Biotechnology Masters programs. This course targets individuals who have some previous training in biomedical sciences, and aims to provide them with the foundations, basic principles, and core concepts in biotechnology and its applications to basic science, health and disease.

TRGN 525 Applications of Genomic Technology in Biomedical Research II (4 units)

This is the second of two courses with the objective to train and provide individuals with strong backgrounds and interests in biological or medical sciences the theoretical and applied knowledge of modern day biotechnology. It will introduce students to tools and applications that will be instrumental throughout the Translational Biomedical Informatics and Translational Biotechnology Masters programs. This course targets individuals who have some previous training in biomedical sciences, and aims to provide them with the foundations, basic principles, and core concepts in biotechnology and its applications to basic science, health and disease.

TRGN 526 Clinical Bioinformatics in Genomic Testing (2 units)

Clinical bioinformatics is generally defined as a specialty of developing and implementing computational methods for acquiring, organizing, storing, and analyzing biological data for improved patient care. In the context of genomic testing, clinical bioinformatics can be defined strictly as the application of bioinformatics methodologies to analyze the genomic data and to identify the genetic and molecular causes of various human diseases. This course aims to provide students a basic understanding of the clinical bioinformatics methodologies and practices, along with the genomic technologies used for clinical diagnostic purposes. The emphasis of this course is on the clinical rather than research applications of these technologies and methodologies. As such, a significant number of the lectures will be centered around the unique challenges associated with genomic testing, and the common practices, standards, and policies developed by the medical communities to address these unique challenges in order to meet the clinical rigor required.

This course aims to provide students with an understanding implementing, versioning, best practices, planning, and bioinformatics within clinical settings. Clinical testing is a

highly regulated environment and specific skills in using emerging methodologies are required within these environments. This course will focus on implementing pipelines in a more mature and regulated environment such as in a clinical laboratory. In these cases, we will train by example with a focus on both new genomic analysis methods and the foundational skills to remain relevant as the field changes.

TRGN 527 Applied Data Science and Bioinformatics (4 units)

The objective of this course will provide students from non-quantitative backgrounds with the skill sets for applying data science and bioinformatics tools in the study of human health and disease using R and Bioconductor. This course is intended for students who are not experts in either data Science or bioinformatics. Students will practice data analysis and data visualization by examining challenges inherent in biomedical data, using common computational and statistical open source tools in data science. Teaching approaches will alternate between lecture and in-class analysis workshops that will focus on to the selection, application, and reproducible statistical analysis of large-scale multi-faceted 'omic' data from publicly available datasets, such as The Cancer Genome Atlas (TCGA) and ENCODE. Within this framework, topics will include basic statistics, hypothesis testing, both parametric and non-parametric analyses (e.g., such as hierarchal clustering and principal component analysis), linear regression analysis, data normalization, reproducibility/sensitivity analysis, multiple test correction, and power assessment Finally, the course will provide an introductory exposure to command-line and Unix-based large-scale data processing, complementing the use of R and Bioconductor as tools for conducting and reproducing analysis frequently required in scientific journals.

INTD 504 Molecular Biology of Cancer (4 units)

Epidemiology, pathobiology, carcinogenesis, tumor biology and heterogeneity, retroviruses, oncogenes, cell cycle control, genetics of cancer, tumor immunology, treatment strategies.

INTD 531 Cell Biology (4 units)

Current perspectives on major research areas in cell biology. Emphasis will be on in-depth examination of cellular structures, regulatory processes, intracellular routing and targeting, and cell/environmental interactions.

INTD 572-573 Systems Physiology and Disease I and II (4 units each)

Mammalian organ systems operation during health, and pathophysiologic analysis of related diseases with focus on muscle, respiratory, cardiovascular and renal systems. Faculty from basic and clinical sciences. Open to graduate students in biomedical science only.

BAEP 551 Introduction to New Ventures (3 units)

Study and development of analytical and conceptual skills in the management of new enterprises and new ventures within large organizations.

BAEP 552 Cases in Feasibility Analysis (3 units)

Study of analytical techniques used to evaluate business concepts and new business development.

BAEP 561 Entrepreneurship in Innovative Industries: Life Sciences (1.5 units)

The challenges of new venture creation in the biotechnology, medical device, and healthcare areas; experience, evaluate, and analyze profits of current impact in the life sciences.

BAEP 563 Corporate Entrepreneurship (3 units)

How established organizations build successful new businesses through corporate venturing and entrepreneurship. Learn to apply an entrepreneurial mindset and entrepreneurial frameworks within an established organization.

Sample Schedule (1 year)
Fall: 12 units

TRGN 536	Biotechnology Primer	Required	4
TRGN 540	Translational Biotechnology Capstone Preparation	Required	1
TRGN 543	Biotechnology Entrepreneurship and Commercialization I	Required	2
TRGN 542	Biotechnology-based Therapeutics	Elective	2
TRGN 546	Biotechnology Intellectual Property, Regulatory, and . . .	Elective	2
TRGN 550	Communicating Science	Elective	1

Spring: 12 units

TRGN 537	Pathway and Target Discovery	Required	4
TRGN 538	Seminar in Translational Biotechnology	Required	2
TRGN 539	Translational Biotechnology Practicum	Required	2
TRGN 544	Biotechnology Entrepreneurship and Commercialization II	Elective	2
TRGN 545	Exploring Chemical and Biological Therapeutic Modalities	Elective	2

Summer: 4 units

TRGN 539	Translational Biotechnology Practicum	Required	2
TRGN 541	Translational Biotechnology Capstone Defense	Required	2

Total 28 units

Sample Schedule (2 years)
Fall: 8 units

TRGN 536	Biotechnology Primer	Required	4
TRGN 540	Translational Biotechnology Capstone Preparation	Required	1
TRGN 543	Biotechnology Entrepreneurship and Commercialization I	Required	2
TRGN 551	Communicating Science	Elective	1

Spring: 8 units

TRGN 537	Pathway and Target Discovery	Required	4
TRGN 538	Seminar in Translational Biotechnology	Required	2
TRGN 545	Exploring Chemical and Biological Therapeutic Modalities	Elective	2

Fall: 8 units

TRGN 539	Translational Biotechnology Practicum	Required	2
TRGN 510	Basic Foundations in Translational Biomedical Informatics	Elective	4
TRGN 542	Biotechnology-based Therapeutics	Elective	2

Spring: 4 units

TRGN 539	Translational Biotechnology Practicum	Required	2
TRGN 541	Translational Biotechnology Capstone Defense	Required	2

Total 28 units