



# Program Approval Form

For approval of new programs and deletions or modifications to an existing program.

### Action Requested:

- Create New (SCHEV approval required except for minors and certificates)
- Delete Existing
- Modify Existing (check all that apply) – M.S. Biology
  - Title (SCHEV approval required except for minors, certificates)
  - Concentration** (Choose one):
    - Add
    - Delete
    - Modify
  - Degree Requirements
  - Admission Standards
  - Application Requirements
  - Other Changes: \_\_\_\_\_

### Type (Check one):

- B.A.
- B.S.
- Minor
- Undergraduate Certificate
- M.A.
- M.S.
- M.Ed.
- Ph.D.
- Graduate Certificate
- Other: \_\_\_\_\_

**College/School:**  **Department:**   
**Submitted by:**  **Ext:**  **Email:**

**Effective Term:** Fall  **Please note:** For students to be admitted to a new degree, minor, certificate or concentration, the program must be fully approved, entered into Banner, and published in the University Catalog.

### Justification: (attach separate document if necessary)

### Program Title: (Required)

Title must identify subject matter. Do not include name of college/school/dept.

### Concentration(s):

### Admissions Standards / Application Requirements:

(Required only if different from those listed in the University Catalog)

### Degree Requirements:

Consult University Catalog for models, attach separate document if necessary using track changes for modifications

### Courses offered via distance: (if applicable)

### TOTAL CREDITS REQUIRED:

Existing	New/Modified
M.S. Biology	
	Translational and Clinical Research
	See attached.
	See attached.
	N/A
	30

## Approval Signatures

Department \_\_\_\_\_ Date \_\_\_\_\_ College/School \_\_\_\_\_ Date \_\_\_\_\_ Provost's Office \_\_\_\_\_ Date \_\_\_\_\_  
*Interdisciplinary Council Use Only*

If this program may impact another unit or is in collaboration with another unit at Mason, the originating department must circulate this proposal for review by those units and obtain the necessary signatures prior to submission. Failure to do so will delay action on this proposal.

Unit Name	Unit Approval Name	Unit Approver's Signature	Date

### For Graduate Programs Only

Graduate Council Member \_\_\_\_\_ Provost Office \_\_\_\_\_ Graduate Council Approval Date \_\_\_\_\_

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## Justification for the Proposed Concentration in Translational and Clinical Research in the M.S. Biology Program

### **Response to Current Needs**

The field of Translational and Clinical Research is vast. In addition to the continuing evolution of existing subfields in biomedicine and clinical research, new subfields are constantly emerging. One example of a new subfield is clinical research that requires an understanding of modern biology as it applies to humans. This subfield heavily relies on the ability to understand, parse and analyze the OMICs-scale biological data - at Mason, the School of Systems Biology is uniquely equipped to teach our students just that. The proposed concentration of Translational and Clinical Research in the MS program will require a broad knowledge of systems biology and OMICs approaches so that students can work effectively in clinical research.

In the course of the past decade, clinical research expertise at Mason has grown exponentially. In 2006, the newly formed School of Systems Biology developed a multidisciplinary research team focused on the central research theme of Chronic Liver Disease and proposed the development of the Center for the Study of Genomic Liver Diseases (CSGLD). This Center was developed as a part of collaborative efforts between George Mason University and Inova Fairfax Hospital's Center for Liver Diseases (CLD). The focus of the Center relies upon the expertise that currently exists in the two institutions, namely the clinical expertise of Inova Health System as lead by Dr. Zobair Younossi and the functional genomics expertise of SSB faculty. The Center brings together the strengths and the expertise of the members from each institution in a collaborative and cohesive environment that enhances the performance of our research team. In 2012-2014, CSGLD faculty made tremendous strides toward discovering and validating novel biomarkers for chronic liver diseases and understanding the pathogenesis of these conditions, resulting in a total of 29 research and review publications (2012-2014 window), 12 of which were co-authored by GMU students. This burst of research activity expanded the Center's expertise. Hence, CSGLD changed its name to the Center for the Study of Chronic Metabolic Diseases (CSCMD).

CSCMD is just one example of the multidisciplinary research team that performs the studies in a variety of biomedical fields. Two other examples are well-known Center for Applied Proteomics and Molecular Medicine's (CAPMM) and National Center for Biodefense and Infectious Disease (NCBID). CAPMM's mission is to: a) create new technologies and make basic science discoveries in the field of disease pathogenesis; b) apply these discoveries and technologies to create and implement strategies for disease prevention, early diagnosis and individualized therapy. The primary emphasis of CAPMM disease research is cancer, but new technologies developed in the center are being applied to a number of important human diseases including cardiovascular disease, diabetes, and obesity, as well as liver, ocular, neurodegenerative and infectious diseases. Faculty affiliated with NCBID play a critical role in advancing research related to infectious diseases, with a focus on host response using proteomics and nanotechnology as they are applied to diagnostic, therapeutic, and vaccine development. A wide array of animal models is being developed at the NCBID with an emphasis on aerosol exposure. The agents of study include, but are not limited to, *Francisella tularensis*, *Yersinia pestis*, *Bacillus anthracis*, *Burkholderia*, Influenza virus, Rift Valley Fever virus, Dengue virus, and encephalitic alphaviruses (Venezuelan, Eastern, and Western equine encephalitis viruses). Thus, an existing expertise at SSB covers a variety of clinically relevant research fields, thus, ensuring the matching project placement of students who select the concentration in Translational and Clinical Research. **Furthermore, this proposed program will be conducted in joint collaboration with the Department of Chemistry and Biochemistry at GMU, further strengthening collaboration efforts between the two departments and ensuring that a rich selection of elective courses and research projects are made available to the students.**

The College of Science was recently awarded a 5-year \$7.8M contract to provide active duty military members with a two-year pre-medical curriculum to prepare them for entry into medical school. The program is called EMDP<sup>2</sup> (Enlisted to Medical Degree Preparatory Program). The first year of the program consists of undergraduate pre-medical courses that are routinely required by most medical schools. In the second year of the program, the students will enter the already existing G<sup>2</sup> Advanced Biomedical Sciences Graduate Certificate program. Once these two programs have been successfully completed, the participants will be eligible to enter the Uniformed Services University of Health Sciences (the nation's federal medical school) or any other medical school to which students are accepted. These students will serve as military physicians once they complete their medical school programs.

The reason why a concentration in Translational and Clinical Research is being proposed is because the federal government, as part of the EMDP<sup>2</sup>, has asked us if we could provide an MS degree completion program to this cohort of students. We have 10 students in this year's entering class (2014), and we will have approximately 20-25 new students every year after that. Since this cohort must take the 20 graduate credits associated with the G<sup>2</sup> ABS program, we propose the Translational and Clinical Research concentration as an extension of that program. The remaining 10 credits for the MS degree would be from pre-existing biology courses. All of the students in the EMDP<sup>2</sup> who successfully complete the G<sup>2</sup> ABS program would take the exact same 10 credits. We don't yet know which courses are preferred by the federal government, so we propose a variety of electives to fill this need for now.

The G<sup>2</sup> program is a joint endeavor offered by George Mason University and Georgetown University Medical Center at the Prince William Campus of Mason, the same location where the majority of the BIOL courses are offered, and where the research labs are located. All of the EMDP<sup>2</sup> students who successfully complete the G<sup>2</sup> ABS Program will gain admission to medical school (Uniformed Services School of Health Sciences or another medical school). Since the G<sup>2</sup> ABS Program consists of 20 credits over 2 semesters, we plan to offer simultaneous enrollment in the MS in Biology (concentration in Translational and Clinical Research) and the G<sup>2</sup> ABS Graduate Certificate Program. With extra effort invested in their graduate level pre-med year, this opportunity will give the students an M.S. degree in Biology.

On paper, it appears that the Georgetown/George Mason (G<sup>2</sup>) MS in Biomedical Sciences is a direct competitor with the newly proposed MS in Biology with a concentration in Translational and Clinical Research (TCR), **but it is not.** The G<sup>2</sup> MS curriculum is comprised of 34 graduate credits that include 6 medical school courses (18 credits) offered by distance lecture capture from the Georgetown University School of Medicine. **None of the credits associated with the G<sup>2</sup> MS may be repeated in the G<sup>2</sup> certificate and students who complete the certificate program are not eligible for admission into the G<sup>2</sup> MS.** Hence, the proposed MS in Biology (with a concentration in Translational and Clinical Research) will provide a mechanism for the EMDP<sup>2</sup> students to earn a terminal graduate degree. The proposed concentration relies solely on in-class instruction and includes research project component. **Hence, the proposed concentration in Translational and Clinical Research is better positioned to cater to these students who will likely continue on into a medical career.**

This concentration is designed for a specific pre-existing population of students and will automatically provide a high level of enrollment (up to 25 each year) due to the nature of the federal contract. It will help the College of Science provide the desired degree program to high-achieving students who will become military physicians. The 10 credits beyond the 20 credits of the G<sup>2</sup> graduate certificate program will also help to support and grow the MS program in Biology.

**In the MS in Biology with concentration in Translational and Clinical Research program, the BMED classes will count as substitutions and electives for BIOL, BIOS or BINF classes.**

**The concentration in Translational and Clinical Research will be open for all students enrolling in MS in Biology.**

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## Student Demand

This concentration is being proposed based on a specific request from the federal government for a degree completion program (beyond the 20 credits of the G2 graduate certificate program). We expect up to 25 students each year based on the EMDP2 contract.

Georgetown University partners with George Mason University to deliver both the G2 graduate certificate program and the MS in Biology with concentration in Translational and Clinical Research. Since the inception of the G2 graduate certificate program in 2010, Georgetown has allowed the joint graduate certificate students to complete 10 unique graduate credits at the Georgetown Campus in DC (after completing 20 joint certificate credits) in order to earn their MS in Physiology. **Approximately half of all students completing the graduate certificate opt to do Georgetown's MS completion program in the summer after the certificate ends. This equates to about 35 students per year. Georgetown charges them their usual graduate student tuition rate which comes to approximately \$18K for extra 10 credits required for graduation with MS. Having that in mind, GMU-based MS in Biology with concentration in Translational and Clinical Research provides very attractive local opportunity for the military students who enroll in the G<sup>2</sup> graduate certificate program.**

**Additionally, this concentration will be also open for non-EMDP2 students enrolled in G2 Certificate.**

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## Admission Requirements

Prospective students should submit standard application materials, including the university application form, undergraduate transcript(s), General GRE scores, personal statement, and three letters of recommendation. Recommended minima include GRE scores of 1100 on the old scale or approximately 303 on the new scale, an undergraduate GPA of 3.00, strong letters of recommendation, and statement of interests consistent with at least one faculty member's research program. Fulfillment of the minimum requirements does not guarantee admission to the program, as availability of an appropriate mentor will be an important part of the admissions decision. We anticipate many more applicants who exceed minimum requirements than can be admitted.

Note: For the EMDP<sup>2</sup> students, Dr. Fox will serve as the coordinator for review of applications under the Translational and Clinical Research concentration of the M.S. Biology Program. These pre-selected applications will be forwarded SSB for final approval. With respect to this concentration ONLY, we will allow students to submit either MCAT or GRE scores as part of the admissions requirements.

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## Degree Requirements

An advisory committee (consisting of three relevant graduate faculty) and the student work together to develop a program of study that best fits the student's background and interests. The student must submit a program of study to the program director for approval within the first semester of graduate work and must complete at least 30 graduate credits.

Students have the option to complete a thesis (3-6 credits of BIOL 799) or a research project (1-3 credits of BIOL 798). According to Mason graduate policies, the same quality of work is expected of students regardless of their chosen option; that is, the MS thesis option or the MS project option. In general, the MS thesis is most appropriate for students planning or considering a research career. The MS project is most appropriate for students who have scheduling commitments that may preclude performing a complete series of laboratory experiments.

The requirements differ primarily at the conclusion of the project, when students pursuing the project option must successfully complete written and oral comprehensive exams. Students pursuing the thesis option must write a formal thesis that meets the requirements of the graduate school, as well as defending their thesis and presenting their results in a public seminar.

\*\*Project: for students not intending bench-level research upon graduation, a non-laboratory project of similar scope to a thesis is an option. This could include work such as a very extensive critical literature review, developing a draft for a grant funding program for a Federal agency, etc.

## Curriculum

### PROPOSED CURRICULUM FOR M.S. BIOLOGY, CONCENTRATION IN TRANSLATIONAL AND CLINICAL RESEARCH (TCR)

#### Research Methodology requirement (1 credit)

*BIOL690 (Intro to Grad studies) or BIOS 702*

#### Seminar requirement (2 credits)

*BIOL695 (Seminar in Molecular, Microbial, and Cellular Biology) or BINF 704(Colloquium in Bioinformatics) or BIOL 508 (R&D in Biotech Company)*

#### Advanced Eukaryotic Cell Biology requirement

*BIOL 682 - Advanced Eukaryotic Cell Biology (3 credits)*

#### Bioinformatics/ Biostatistics requirement

*BINF 630 or STAT 535 (3 credits)*

#### Human Genes, Cells and Tissues requirement

*BIOL666 or BIOL 572 or BIOS 743 (3 credits)*

#### Biochemistry requirement

*BIOL 583 or CHEM 563 or CHEM 660 (3 credits)*

#### Research component (1-6 credits)

*Students must complete either a 1-3 credit research project or a 3-6 credit MS thesis.*

#### Electives

**(please refer to recommended list of electives that includes BINF, BIOL, CHEM and STAT classes)**

#### CURRICULUM NOTES:

- **For G<sup>2</sup> students, the 20 credit hours of BMED courses can be counted towards the MS certificate degree.**
- NOTE: BIOL 798/ CHEM 798 and BIOL799/CHEM799 ARE TO BE TAKEN FOR 3 CREDITS, THESE CREDITS MAY BE SPLIT BETWEEN SEMESTERS (TO START AS EARLY AS FALL OR SPRING)

#### ADMISSIONS NOTES:

For the EMDP<sup>2</sup> students, Dr. Fox will serve as the coordinator for review of applications for the Translational and Clinical concentration of the M.S. Biology Program; these applications will be also screened by SSB faculty and MS in Biology coordinator, Dr. Baranova, before the final admission decision.

**Students who wish to graduate with G<sup>2</sup> certificate and MS program should be enrolling in both programs at the same time; otherwise they will be subject to 18-credits residency requirement (would have to take 8 extra credits in MS program, to a total of 38)**

With respect to this concentration **ONLY**, we will allow students to submit either MCAT or GRE scores as part of the admissions requirements.

### **RELEVANT BIOL, or BIOS, or CHEM ELECTIVES**

#### **BIOL 568 - Advanced Topics in Molecular Genetics**

Credits: 3 (RD)

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Comprehensive study of regulatory mechanisms controlling gene expression in viruses, prokaryotes, and eukaryotes, emphasizing current research.

#### **BIOL 566 – Cancer Genomics**

Credits: 3 (NR)

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Review of modern concepts in cancer biology including taxonomy of human tumors, common cancer syndromes, and genome instability. Genetic and molecular studies of tumor cell proliferation, migration, invasion, and death.

**Prerequisite(s):** course in Genetics or Biochemistry.

#### **BIOL 562 – Personalized Medicine**

Credits: 3 (NR)

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Covers basic principles of molecular medicine, including the definition and the need for individualized diagnostics and therapeutics. Students will study the application of proteomics, genomics and bioinformatics as they relate to individualized therapy, and review the major advances in these fields which have relevance to molecular medicine of the future.

**Prerequisite(s):** Advanced undergraduate coursework in Genetics and Molecular Cell Biology.

#### **BIOS 741 - Genomics**

Credits: 3 (NR)

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Genetic structure and function at whole genome level. Includes some sequence analysis, comparative genomics, classical genetics, and developmental genetics, as well as analysis of synteny groups, isochores, gene families, genetic complexity, C value paradox, directed discovery of gene functions, and animal models of human disease. Readings from recent texts and primary research literature. Students expected to give one or two oral presentations of primary research papers, as well as complete midterm and final exams.

**Prerequisite(s):** At least one undergraduate course in genetics and molecular biology, or permission of instructor.

#### **BIOS 742 - Biotechnology**

Credits: 3 (NR)

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Theory and applications of biotechnology. Includes promoter design, gene fusions, protein targeting, techniques of protein purification, construction of transgenic organisms, cloning of animals and plants, ethical and legal issues. This is a relatively new area of study that is rapidly changing; course strives to keep students abreast of current literature.

**Prerequisite(s):** Undergraduate course work in genetics and molecular biology.

**BIOS 743 - Genomics, Proteomics, and Bioinformatics**

Credits: 3 (NR)

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Fundamental methods for analyzing genomic and proteomic data, including nucleic acid and protein sequences, pair-wise and multiple alignment, database search methods, clustering and presentation of data, prediction modeling, and survey of available software and freeware tools.

**Prerequisite(s):** Admission to Biosciences PhD or Biology MS program.

**BIOS 744 - Molecular Genetics**

Credits: 3 (NR)

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Develops understanding of principles of modern molecular genetics and methods of investigation of genomes of pro- and eukaryotes, including types of genetic manipulations conducted in research laboratories today.

**Prerequisite(s):** Undergraduate course work including BIOL 311; CHEM 313, 314, 315, and 318; equivalents; or permission of instructor.

**BIOL 553 - Advanced Topics in Immunology**

Credits: 3 (RD)

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Comprehensive study of immunologic mechanisms as they pertain to immunologic diseases and transplantation.

**Prerequisite(s):** BIOL 452, or permission of instructor.

**BIOL 563 - Virology**

Credits: 3 (NR)

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Fundamental concepts of nature of viruses, virus classification, cultivation, and biochemistry. Emphasizes bacteriophage and animal viruses.

**Prerequisite(s):** BIOL 482, or permission of instructor.

**BIOL 669 - Pathogenic Microbiology**

Credits: 3 (NR)

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Molecular mechanisms of bacterial pathogenicity and immune response in infectious diseases.

**Prerequisite(s):** Courses in microbiology and biochemistry.

**BIOL 715 - Microbial Physiology**

Credits: 3 (NR)

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Comprehensive study of functioning of microbial cells, with emphasis on pathogens. Stresses growth, transport, cell-to-cell signaling, biofilm formation, antibiotic resistance, and secondary metabolites.

**Prerequisite(s):** Undergraduate lecture/lab course in microbiology, and course in biochemistry.

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### **CHEM 567 - The Chemistry of Enzyme-Catalyzed Reactions**

Credits: 3 (NR)

Examples of enzyme mechanisms demonstrate how chemical principles are employed by living organisms. Specific enzyme mechanisms used to illustrate principles from organic, inorganic, and physical chemistry. Discusses techniques to monitor enzyme reactions.

**Prerequisite(s):** CHEM 313 and 463 or permission of instructor.

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### **CHEM 579 - Special Topics**

Credits: 1-6 (RT)

Current topics in chemistry, depending on instructor's specialty.

**Prerequisite(s):** CHEM 313 and 314 or permission of instructor.

Notes: May be repeated with different topics, with department approval.

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### **CHEM 624 - Principles of Chemical Separation**

Credits: 3 (NR)

Theories and models of separation with applications to analyses of a wide range of chemical, biological, and environmental samples. Topics include high-resolution gas and high-performance liquid chromatography. Emphasizes theory of reverse phase, normal phase, ion exchange, size exclusion, and affinity based separations. Also presents instrumentation such as detectors, pumps, and columns, and data acquisition. Analytical core course.

**Prerequisite(s):** CHEM 422 or 521, or permission of instructor.

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### **CHEM 660 - Protein Biochemistry**

Credits: 3 (NR)

Proteins play critical roles in most biological processes. Therefore, to understand these processes, it is necessary to understand proteins. This course will introduce students to proteins, their biosynthesis/biodegradation and their biophysical and biochemical properties. Biochemistry core course.

**Prerequisite(s):** CHEM 463 or equivalent or permission of instructor.

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### **CHEM 661 - Antibiotic Chemistry and Resistance**

Credits: 3 (NR)

Introduces the various classes of antibiotics. Focus on the chemistry of antibiotics and how they inhibit bacterial growth and/or cause death and the response of bacteria to these compounds.

**Prerequisite(s):** CHEM 463 (or equivalent), or permission of instructor.

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### **CHEM 662 - Modern Methods of Drug Discovery**

Credits: 3 (NR)

Introduction to the process of drug discovery. Covers modern methods and strategies of target identification, lead identification, and lead optimization. Biochemistry core course.

**Prerequisite(s):** CHEM 463 (or equivalent), or permission of instructor.  
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**CHEM 665 - Protein-Protein Interactions: Methods and Applications**

Credits: 3 (NR)

Introduction to the fundamental principles of protein-protein interactions, including experimental design considerations and methods for quantification of these interactions.

**Prerequisite(s):** CHEM 463 (or equivalent), or permission of instructor.  
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**CHEM 796 - Directed Reading and Research**

Credits: 1-6 (RD)

Reading and research on a specific topic in chemistry or biochemistry under direction of a faculty member. May be repeated for a total of 12 credits.

**Prerequisite(s):** Admission to a graduate program in chemistry and biochemistry or affiliated programs.  
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**STAT 560 - Biostatistical Methods**

Credits: 3 (NR)

Focuses on biostatistical aspects of design and analysis of biomedical studies, including epidemiologic observational studies and randomized clinical trials. Topics include randomization principle, confounding, ethics in human experimentation, methods of randomization, stratification, primary outcome analyses, covariate-adjusted analyses, epidemiologic measures, and sample size and power computation.

**Prerequisite(s):** STAT 554 or STAT 535; and a working knowledge of a statistical software package, such as SAS or SPSS.

**Hours of Lecture or Seminar per week:** 3

**Hours of Lab or Studio per week:** 0

**When Offered:** Spring  
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**PROJECT or THESIS CREDITS**

**BIOL 798 - Master's Research Project**

Credits: 1-3 (RD)

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Experimental or theoretical research project chosen and completed under guidance of graduate faculty member. Comprehensive report acceptable to student's advisory committee is required.

**Prerequisite(s):** Permission of instructor and department chair.  
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**BIOL 799 - Thesis**

Credits: 3-6 (RD)

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Thesis research under direction of supervisor.

**Prerequisite(s):** 8 graduate hours in BIOL and permission of instructor.

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