

# Advising Biology Majors about Career Choices: Resources & Information for Biology Instructors

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## ABSTRACT

It is essential that undergraduate biology majors are made aware of and receive guidance on career possibilities. The authors, who actively advise and teach biology majors (and future majors) at both the high school and undergraduate levels, collaborated to identify resources and methods to advise biology majors about their career choices. Multiple resources were identified. Current advising theory recommends a method of supporting students to make wise choices by considering personal vision, the kinds of professional successes desired, and individual talent development. U.S. Bureau of Labor Statistics, U.S. Census Bureau, and National Science Foundation data were analyzed to identify potential jobs that biology majors can attain. These resources and strategies should help faculty advisors and instructors inform biology majors about possible career paths.

**Key Words:** Advising; biology careers; jobs; workforce.

## ○ Introduction

With increased numbers of students attending college in recent years and the push for 1 million more STEM (science, technology, engineering, and mathematics) graduates (President's Council on Science and Technology, 2012), it has become more pressing than ever for advisers and students to know where jobs will be available to them in the future. Using U.S. Bureau of Labor Statistics (BLS) and U.S. Census data, we have identified numerous fields that are experiencing an increase in job availability in the coming years. The intention of this article is not to encapsulate all of the careers that are possible with a biology degree, but to instead provide a greater awareness of where the job possibilities are and to provide advisors with resources to understand these possibilities given the current BLS projections (U.S. Bureau of Labor Statistics, 2012). Advising strategies recommended by the National

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Academic Advising Association (NACADA) and Vincent Tinto, whose articles have set the standard for advising, having been shown to increase student retention rates and the alignment of students' career and education goals (Tinto, 1987; Richardson, 2013), will be highlighted here as strategies that should be utilized by advisors.

## ○ Personal Perspective on Advising Students

The three authors of this article have reached out to their colleagues and peers, in addition to examining the economics data, to get a handle on how best to advise biology students. We chose to look at advising strategies and the BLS data in order to create a combination of perspectives on the advising experience and how advisors should be appropriately counseling students in high school and college about being a biology major. Our views about advising rest squarely on the shoulders of NACADA, which defines academic advising as "a series of intentional interactions with a curriculum, a pedagogy, and a set of student learning outcomes. Academic advising synthesizes and contextualizes students' educational experiences within the frameworks of their aspirations, abilities and lives to extend learning beyond campus boundaries and timeframes" (Drake, 2011). It is critical that universities note that academic advising is at the very core of successful institutional efforts to educate and retain students (Tinto, 1987).

Various advising approaches have been developed as a result of Vincent Tinto's work in 1987; these include the developmental teaching perspective, the intrusive perspective, prescriptive advising, and the development of a normative theory of advising as a combination of all these approaches (Jeschke et al., 2001; Peters et al., 2010; Himes, 2014; Davis, 2015; McGill, 2016).

Historically, developmental advising has been the most prevalent form of advising, and it upholds several concepts that encourage students to cultivate ways of thinking about the decision-making process. These include a learner-centered approach, a balance of challenge and support from the advisor's perspective, and a belief that students should be taught explicitly about the process of arriving at a decision (McGill, 2016). However, recent studies suggest that prescriptive and developmental advising approaches are not as effective as intrusive advising, which is described by Jeschke et al. (2001) as consistent contact between advisors and students during critical periods throughout the school year (Davis, 2015). Alternatively, normative theory suggests a combination of approaches that cater to the individual student's needs and career aspirations by fitting the distinct goals, knowledge, and prior experiences the student has (Himes, 2014). All of these advising strategies have their own strengths, weaknesses, and challenges associated with them; advisors must search the literature and their own experiences to determine the best approach to utilize when advising their own students. The most successful advisors take time to learn each student's story, identify the student's strengths and challenges in this new environment, and respectfully and effectively link these students to the resources that will best suit their individual needs (Peters et al., 2010).

## ○ Comprehensive Summary of Approach

The BLS projections, online career resources, and advising strategies provided should aid advisors at both the high school and the undergraduate level to effectively mentor their students on potential career paths. Our view is that advisors should (1) have a general knowledge of the career possibilities available to persons with a bachelor's degree in biology, including additional applicable fields of interest and successful placement into graduate programs; (2) have a general knowledge of the steps a biology major must take to achieve any of the aforementioned career possibilities; and (3) be available to students to discuss their interests and career planning to provide them the greatest chance of success. We hope this information helps advisors form a good relationship with their students for optimal advising and later career success.

## ○ Methods of BLS Data Analysis

In order to gain a complete grasp of the projected careers for biology majors with a bachelor's degree, the authors searched BLS, National Science Foundation (NSF), and U.S. Census data (National Science Board, 2012b; U.S. Bureau of Labor Statistics, 2012; U.S. Census Bureau, 2014). Initially, the BLS data were searched using "BIOL" in the search field to determine which projected careers would appear within a biology focus. Although some health-related positions appeared under the "BIOL" search, the majority of these occupations and specialties appeared when "health," "doctor," and "nurse" were used as key words. The BLS data were used first; NSF and U.S. Census data were then brought in to determine similarities in the projected numbers of biology and health-related jobs available to undergraduate biology majors. The U.S. Census and NSF data were also used to (1) illustrate the gap between the number of biology majors graduating per year and the availability of health careers and (2) demonstrate the need for awareness of alternative career paths in biology.

The collected data were used to create three tables (which ultimately became Tables 1–3 presented here), which were then scoured for job descriptions that seemed similar to the career interests reported by students enrolled in a cell biology course taught by one of the authors (see below). The authors analyzed a database of this information to determine the reported career plans of these biology majors. The notecard data collected for the cell biology course were used to analyze the distribution of potential careers that entry-level biology majors consider.

Upon completion of the tables, the number of jobs presented in each table was reduced in order to provide readers a more concise representation of jobs available to biology majors. Jobs kept in the tables and presented here were chosen because of their high numbers of available occupations and interest indicated by the surveyed students. Additionally, some jobs were lumped into the same larger categories (i.e., health or education occupations), with their total numbers provided in the table. The complete tables can be found in a google document (<https://goo.gl/4MvZNd>).

As noted above, we had conversations with instructors concerning how best to advise students; these conversations contributed to the discussion on advising presented here. NACADA and research published by or in reference to Vincent Tinto were reviewed by the authors to find the strategies most applicable to advising biology students on career prospects. The conversations held with high school and college instructors/advisors, as well as a graduate student, were synthesized with the research found on advising theory to come up with a comprehensive approach to advising biology majors.

## ○ Increasing Number of Biology Jobs

While the number of jobs that will be available to graduates is important, it is equally important to note the fields in which students wish to be employed upon completion of their degree. Dr. James Schwebach surveyed 217 biology students in a 100-level cell biology course at George Mason University who were asked to fill out notecards with their interest in non-STEM careers, future plans, and prior colleges. Of the biology students who were asked to complete the notecards, 66% planned on attending some form of postgraduate school geared toward health-related professions, while the other 34% were interested in non-STEM or STEM research-related professions.

The total predicted U.S. population for 2022 is 338,930,000, as reported by the U.S. Census Bureau, which is a population change of approximately 0.75%, or 2,515,000 people, over the next eight years (U.S. Census Bureau, 2013). According to the data, future jobs in biology are predicted to be in medical/health and education fields, which encompass a wide range of professions. The most recent numbers, with no known projections, are those reported by the NSF indicators, which show that a total of 66,669 biological science degrees were awarded in 2009: 51,756 undergraduate, 9921 graduate, and 4992 doctoral (National Science Board, 2014). There is a predicted 6.12% increase in "BIOL" jobs according to STEM education data published by the NSF (National Science Board, 2012a). Additionally, 21.2% of science and engineering bachelor's degrees will be awarded in biological/agricultural sciences (National Science Board, 2014). It should be noted that there is a discrepancy in the number of students graduating with biology degrees in anticipation of health careers and the number of health careers predicted to be

available. That is not to say that every biology major wants to enter the health field; and, in fact, some biology majors don't end up in a biology-related career field.

## ○ Majority of Biology Majors Could Find Work in a Field Related to Their Major

In summary, a predicted 138,000 jobs will be added in explicitly biology-major-related fields, which will present a dilemma for recent biology graduates looking for jobs within their field (Table 1). It is important to note that the majority of "BIOL" careers included in the BLS data will increase by <8000 jobs. Further, while the majority of reported jobs that appeared in our "BIOL" search are increasing in number, "biological scientists, all other" is showing a 0.4% decrease in its number of reported jobs for 2024 (Table 1). There is a trend for biology majors to transition into fields that do not require a biology degree (U.S. Census Bureau, 2014).

## ○ Biology Majors Don't Always Pick Careers in Biology

The vast majority of biology majors are choosing this degree as a pathway to health-care positions (Leonard, 2012), and the number of such jobs that are available to graduating students is consistently increasing. But while the majority of jobs available for biology graduates are in health care and education, students should be advised of other fields as well. For example, bus and truck mechanics and

diesel engine specialists will make up approximately 296,000 jobs in 2024, adding a considerable number of possible careers to the workforce for graduating biology majors interested in mechanics (see Table 1; <https://goo.gl/4MvZNd>). In addition, biology majors should consider career opportunities in nontraditional scientific areas like writing. The projected demand for authors and writers by 2024 is 140,000 (Table 1; it is important to note that not all of these writing positions will be for specifically scientific purposes).

When students begin looking for potential careers, it is important for them to consider their projected average income; for example, the approximate income for "writers and authors" is \$58,805, whereas the average salary for technical writing, which is more specialized, is \$69,030. And BLS reports do not account for the large percentage of part-time-employed writers that were not part of this analysis (U.S. Bureau of Labor Statistics, 2014). In all cases, the advisor should have a tacit awareness of the full-time employability (and need for employees to move for work) in many different fields. We recommend that the advisor develop this knowledge base at the local level.

Among the 217 biology students surveyed in the cell biology course taught by Schwebach, only 7 identified themselves as being interested in zoology, marine biology, or conservation sciences upon completion of their bachelor's degree. The more overtly biology-related jobs in zoology and wildlife biology are experiencing only a 4.9% increase in jobs over the course of 10 years (Table 1). Significantly, there is a 3% increase in the number of conservation biology graduates, which, when compared to the 4.9% increase in conservation-related jobs, should mean that there will be jobs available for majors graduating in this field (U.S. Census Bureau, 2013). This

**Table 1. U.S. Bureau of Labor Statistics projections of "BIOL"-related jobs in 2024. According to the National Science Foundation, there will be a 6.12% increase in "BIOL" jobs. All numbers are in thousands.**

Occupations	Employment		Change in employment	
	Number of Jobs in 2014	Number of Jobs by 2024	Change in Number of Jobs	Percent Change
Biochemists and biophysicists	34.1	36.9	2.8	8.2
Biological science teachers, postsecondary	64.3	74.8	10.4	16.2
Biological scientists, all other	36.4	36.2	-0.2	-0.4
Biological technicians	79.3	83.5	4.1	5.2
Biomedical engineers	22.1	27.2	5.1	23.1
Bus and truck mechanics and diesel engine specialists	263.9	295.5	31.6	12
Forestry and conservation science teachers, postsecondary	2.3	2.4	0.2	6.8
Medical and clinical laboratory technologists	164.8	187.9	23	14
Medical equipment repairers	48	50.9	2.9	6.1
Microbiologists	22.4	23.2	0.8	3.4
Secondary school teacher, except special and career/technical education	961.6	1017.5	55.9	5.8
Writers and authors	136.5	139.7	3.1	2.3
Zoologists and wildlife biologists	21.3	22.2	0.8	4

discrepancy in numbers can be explained by the small number of students that are annually enrolled in conservation-related programs at the university level.

By 2024, it is predicted that there will be an addition of 2.9K “medical equipment repairer” positions to the workforce, which is the largest jump in “BIOL” occupations (Table 1). This is, however, due to the small number of medical equipment repairers currently employed in comparison to teachers or mechanics, which have a significantly higher number of employed workers at the present time. An increase in the number of medical and clinical laboratory technologists provides another opportunity for students who want to enter health care but are not willing to put in the time for a continuation of higher education; for example, there are various technologist positions available to students with associate’s degrees who do not wish to pursue any further education. There is predicted to be an addition of 23.1K technologist jobs to the field by 2024, which will provide another opportunity for a potential career for biology majors (Table 1). Education is another large field with possible careers for graduating biology majors; teachers, both in postsecondary and secondary schools, will increase in employment, adding nearly 66,300 jobs to the workforce from 2014 to 2024 (Table 1).

## ○ Many Biology Majors Will Pursue Careers in Health

Of the 217 biology majors surveyed, 89 planned to attend medical school (41%), 5 planned to attend optometry school (2%), 33 planned to attend dental school (15%), and 23 planned to pursue a career in some other health field, like physician assistants and physical therapists (11%). In fact, the vast majority of biology majors are choosing to enter health-related fields, which are experiencing an ever increasing addition of jobs (Leonard, 2012; National Science Board, 2014). Approximately 4,222,500 professionals worked in the health-care field in 2012; of those, 827,565 were biological, environmental, or agricultural science majors (National Science Board, 2014). Job growth of  $\geq 30\%$  is projected in most health-care fields (Table 2).

## ○ Nursing Is an Exceptional Career Path for Biology Majors

A search for health-related fields identified 11 careers with >10 million positions: registered nurses and nursing assistants were predicted to

**Table 2. U.S. Bureau of Labor Statistics (BLS) projections of health jobs in 2024. We organized BLS data forecasting health careers. In 2024, there are expected to be 9663.9K jobs needing a biology degree or similar degree, 78% of them in health. All numbers are in thousands.**

Occupations	Employment		Change in Employment	
	Number of Jobs in 2014	Number of Jobs by 2024	Change in Number of Jobs	Percent Change
<b>Under “health”</b>				
Dentists, all other specialists	6.7	7.3	0.6	8.5
Health educators	61.4	68.9	7.5	12.2
Health specialties teachers, postsecondary	210.4	250.4	40	19
Health-care practitioners and technical workers, all other	44.2	50.3	6.1	13.8
Health-care social workers	160.1	191	30.9	19.3
Medical and clinical laboratory technicians	163.4	192.4	29	17.8
Nurse practitioners	126.9	171.7	44.7	35.2
Registered nurses	2751	3190.3	439.3	16
<b>Under “nurse”</b>				
Nurse anesthetists	38.2	45.6	7.4	19.3
Nurse midwives	5.3	6.6	1.3	24.6
Nursing assistants	1492.1	1754	262	17.6
<b>Under “doctor”</b>				
Family and general practitioners	139.8	154.1	14.3	10.2
Internists, general	54.3	59.4	5.1	9.4
Optometrists	40.6	51.6	11	27
Physicians and surgeons, all other	347.2	398.8	51.7	14.9

**Table 3. U.S. Bureau of Labor Statistics (BLS) projections of all other author-chosen “BIOL”-related jobs. In a third search of the BLS data, the authors identified an additional 20 occupations (narrowed down into specific categories, i.e., “education”) for biology majors to consider in their career searches. All numbers are in thousands.**

Occupations	Employment		Change in Employment	
	Number of Jobs in 2014	Number of Jobs by 2024	Change in Number of Jobs	Percent Change
Education, instructional	4837.5	5140.2	302.7	5.9
Education, noninstructional	516.9	551.8	34.9	6.3
Agricultural engineers	2.9	3	0.1	4.4
Animal scientists	2.9	3.2	0.2	7.3
Camera operators, television, video, and motion picture	25.4	25.9	0.5	2
Cartographers and photogrammetrists	12.3	15.9	3.6	29.3
Child, family, and school social workers	305.2	324.1	19	6.2
Computer occupations, all other	233	240.8	7.7	3.3
Editors	117.2	111	-6.2	-5.3
Exercise physiologists	14.5	16	1.5	10.6
Food scientists and technologists	15.4	16	0.5	3.5
Foresters	15.5	16.8	1.3	8.3
Genetic counselors	2.4	3.1	0.7	28.8
Life scientists, all other	10.6	11.3	0.8	7.2
Life, physical, and social science technicians, all other	78.2	83.5	5.3	6.8
Natural sciences managers	55.1	56.9	1.8	3.3
Orthodontists	8.2	9.7	1.5	18.3
Technical writers	52	57.3	5.3	10.2
Veterinarians	78.3	85.2	6.9	8.9
Health-care-related fields	432.6	475.5	43	0.1

provide >5 million jobs, making this field an important potential option for biology students who have acquired their bachelor’s degree. Additionally, health specialties teachers will provide approximately 259,000 jobs in 2022, when increased specialization in the field will have increased the demand for such teachers to provide instruction to incoming pre-health students (Table 2). There is an increase of 37,000 in the number of nurse practitioners (a total of 147,000); this change is greater than the number of family and general practitioners, which is approximately 18,000 (a total of 142,000) (Table 2). In all other nursing fields, the number of jobs available by 2022 will represent an increase of ≥20%, opening up opportunities for degree-holding biology majors. This increase in the demand for nurses and other nursing professionals could be due to the increase in health-care demands because of an ever increasing population, as well as an increase in the number of elderly in need of long-term health care in nursing homes and retirement facilities (Ortman et al., 2014). Nursing is another field that increases pay with specialization; prospective

nurses can expect to receive anywhere from \$25,100 to \$152,780, which is an important factor for students to consider when they are deciding what kind of nurse they would like to be.

Physicians and surgeons also show an increase of 65,000 jobs to the workforce, which contributes to a total number of 414,000 positions (Table 2). These fields see the largest increase in employment, which could be accredited to the increase in the demand for medical care for chronic diseases and other age-related health problems (Ortman et al., 2014). Other health-related fields that do not directly involve patient care are available to biology graduates who want to enter the field. A significant increase (~73,000 jobs) in the field of medical and health services management is also predicted, most likely due to the changing practices in medical care along with a higher demand for medical care due to an aging population who are living longer than previous generations. Health-care social workers will also increase by approximately 40,000 jobs to comprise a total of 186,000 in 2022 (Table 2).



**Table 4. Search engines for career exploration. Each of these resources can be utilized by advisors and current biology students to search for information about a number of different biology-related careers. These resources were investigated by the authors and evaluated on the basis of categories important for a thorough career search.**

	O*NET <sup>1</sup>	HHMI <sup>2</sup>	NSF <sup>3</sup>	AAAS <sup>4</sup>	Sloan Career Cornerstone Center <sup>5</sup>	Explore Health Careers <sup>6</sup>
Large number of diverse fields and scientific careers	X	X		X	X	X
Allows for concise search based on interest	X			X	X	
Provides overviews of careers	X	X	X	X	X	X
Provides classified ads for contact					X	X
Allows for thorough exploration of field and site	X			X	X	X
Educational level required and job growth projections provided	X	X	X	X	X	X
Allows for search based on skills required	X			X	X	

<sup>1</sup> <https://www.onetonline.org/>, <https://goo.gl/yk24Ek>

<sup>2</sup> <http://www.hhmi.org/careers>, <http://goo.gl/zVvPQV>

<sup>3</sup> <https://www.nsf.gov/careers/>, <https://goo.gl/GGhRk9>

<sup>4</sup> <http://www.aaas.org/careers>, <http://goo.gl/psZSDP>

<sup>5</sup> <http://www.careercornerstone.org/>, <http://goo.gl/md1Yxe>

<sup>6</sup> <http://explorehealthcareers.org/en/home>, <http://goo.gl/h8XLMZ>

These numbers demonstrate the importance of health care as a market and as a place where graduating biology majors can acquire jobs. The versatility in health care opens up various jobs for students completing their bachelor's degree in biology (Leonard, 2012) and offers an opportunity for job security in the face of changing population demands.

When the BLS data were combed for any remaining jobs that could directly pertain to biology majors, an additional five health-care careers were identified. These include pharmacists, who will have an additional 328,000 jobs in the workforce by 2022 (Table 3; <https://goo.gl/4MvZNd>).

As mentioned above, while the majority of biology majors will enter health care, education, and biology-oriented fields, some degree-holding biology majors will enter a variety of other professions that provide ample opportunity for job growth and stability. The BLS data also identified 15 instructional education jobs that would be useful to biology majors. Individually, all but one of the fields (nursing instructors and teachers, postsecondary) displayed a <15% increase in the number of jobs they will be adding to the workforce (Table 3). However, the demand for educators at all levels will always be a large contributor to the number of positions available. Additionally, four noninstructional jobs in education were also highlighted in the BLS data, which will add approximately 51,000 jobs to the workforce collectively (<https://goo.gl/4MvZNd>). These increases demonstrate that education as a field will remain an option for all biology majors as they enter the workforce upon their completion of a bachelor's degree.

There are some positions that appeared when the data were examined, but that did not appear in the "BIOL" search, which are

directly applicable to the biology major and are showing positive growth over the next 10 years. Genetic counselors are showing a 41.2% increase in the number of jobs they will be adding to the workforce, but this large percentage is a product of the small number of jobs existing in 2012 (2.1K). Life scientists, as well as life, physical, and social science technicians and natural science managers, will comprise approximately 136,000 occupations, which opens up numerous other career pathways for the graduating biology major (Table 3). Growth in the need for technology will be important for biology majors as a result of the need for computers and other technological advances when conducting and publishing research findings in the field. As such, computer occupations are showing a slight increase in the number of jobs that will be available in 2022 (Table 3). This is significant to biology majors and advisors because it sheds light on yet another career opportunity for the technology-experienced biology major if they must adjust their career trajectory.

## ○ Resources for the Advisor & Instructor

The short answer is that advisors cannot know everything there is to know about advising the undergraduate biology student, but they can inform students of how to find answers using reference books, online resources, and colleagues' expertise. In fact, knowing how to find answers is more useful than knowing the answers, for two reasons: (1) part of advising is teaching students how to find answers for themselves; and (2) the field of pre-health advising changes rapidly, so it is crucial to check current sources frequently for new information (Bingham & Childress, 2008; McGill, 2016).

**Table 5. Tips for using online career-search resources (see Table 4).**

Name	Description
O*NET	This search engine allows students to focus on skill sets and career options and to easily navigate apprenticeships and internships. Consider the “bright-outlook” and “green” categories for future job prospects.
HHMI	This search engine provides students with a brief summary of career responsibilities and qualifications within a specific area of expertise alongside related job openings.
NSF	Students are provided with a narrow search within possible NSF career fields, most requiring a PhD or equivalent degree. Current students and recent graduates should consider looking toward the “Pathways Program.”
AAAS	This search engine gives students the ability to refine their search based on discipline, location, etc., with extensive information provided under each job listing. Consider the “more jobs like this” and sciencecareers.org categories for additional job prospects.
Sloan Career Cornerstone Center	Consider this resource for guidance in career planning alongside a search for job opportunities. Categories in the biology field highlight preparation for a job in the field, specialty areas, earnings, employment, career path forecast, professional organizations, and profiles of current biologists.
Explore Health Careers	This resource is useful to students interested in health careers; it offers information about professional associations, funding opportunities, enrichment programs, and academic programs. Also, consider this resource for a more diverse search of possible career fields (e.g., forensics, arts, and humanities).

In general, there is not a specific formula for instructors to use in advising undergraduate biology students. An instructor should be cognizant of the potential jobs and sensitive to individual students’ career ambitions. When advising students, instructors must consider multiple factors that go into increasing student retention rates and success in their undergraduate years. We suggest that instructors have a basic understanding of these influences on students’ pathways and how they should be addressed when advising students on their career ambitions. Additionally, Tinto and NACADA suggest several strategies and methods for advising students, all of which hold that students should work closely with instructors who also have a mentoring capacity, in order to create the most effective advising experience.

Therefore, given the constraints described above, we decided to consult other advisors, and search the Internet and literature, to create a list of resources that would provide advisors information about biology-related careers. These resources are shown in Tables 4 and 5. Table 4 lists the resources we found, and Table 5 lists our suggestions for optimal use of these resources.

We found the most useful of these resources to be O\*NET, AAAS, and Sloan Career Cornerstone Center, because these provide the most specific information on careers, such as salary, likelihood of employment, how to become qualified for employment, and similar information that a student should consider when making decisions. We hope these resources are useful for advisors and students.

## ○ Acknowledgments

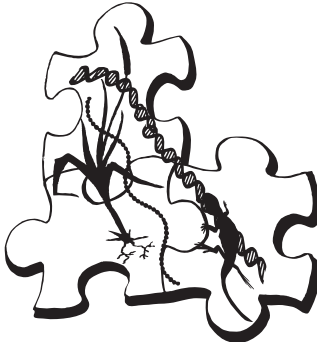
Dr. Schwebach was supported by NSF grants 1240031 (NOYCE) and 1347675 (WIDER). Katherine Araneo was also supported by NSF grant 1240031 (NOYCE).

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