Review Article

A Simple Guideline for Applying Online or Offline Biochemical/Biological Databases Targeting Undergraduate Students up to Postgraduate Ones

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Abstract

About half a century ago, perhaps few people thought that the development of a particular type of viral disease and the vaccination process would take nearly a year; however, it happened (successful or unsuccessful). The best tool to help researchers in this direction is the subsequent development of computer-based science and proprietary processes. As we all know, biological science is largely attributed to the development of computers and artificial intelligence in the identification, prevention, and treatment of various diseases. The different overlap between these two disciplines has always attracted the audience of its attributes in the interdisciplinary field. For a specific group of science students, one of the disadvantages is familiarity with how they work and how to distinguish between databases. Many databases for researchers have been developed online in their specific fields. Searching and using this series of data on the Internet has become a common practice, which means that for a professional researcher, this in itself turns into an advantage. However, some groups are interested in using these data and do not have the special information as experienced researchers. This article briefly attempts to introduce a simple ladder of biochemical science and biology based solely on cyberspace.

Keywords: Biomedical Enhancements, Biomedical Technologies, Computational Molecular Biology

Introduction

Due to the rapid development of computer technology in industrialized and developed countries, it can be boldly said that there are few cases in which computers have not been used (1), and these applications are expanding day by day (2). Human endeavors have always focused on creating and developing tools and methods that replace human physical force or mental powers (3). Using computers in biology and life sciences is no exception to this rule (4). As scientists re-engineer cellular activity for specific purposes (5), computer science terms and concepts have become more common in biological laboratories (6).

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Scientists have also developed unprecedented capabilities from genome-editing tools (7). For example, methods targeting viruses or proteins called Zinc Finger (8), besides, new CRISPR-Cas9 technology, allow genome editing more purposefully (9). Scientists are creating large sets of information to determine what effect each of these compounds will represent by changing the transcription factors involved in DNA replication in different combinations bit by bit (10). All these advances in the field of life sciences, biology, and especially biochemistry outside the existence of tools such as computers and related software, both online and offline, are considered very difficult and grounded; whereas, the rapid advancement of science requires the analysis of vast amounts of data and accurate evaluation in the shortest possible time (11). This article is an uncomplicated and concise attempt to introduce the basics of computer uses in clinical and research laboratories for novices, which will be discussed in more detail subsequently.

Material & methods

In this review, extensive investigations in PubMed, Scopus, and Google Scholar have been performed using keywords including Biomedical innovations, Biomedical sciences, Molecular biology, Biochemical modeling, and Simulation theory (1968-2021). Accordingly, the most important research papers about this subject based on the quality and level of pieces of evidence have been collected, categorized, and discussed.

Results

Directory, library resources, databases, and tools

Due to the complexity and plethora of websites available, anyone can quickly get confused (12). Therefore, in the three tables mentioned below, a list of useful websites is given, which is especially suitable for studying biochemistry and other life sciences (13). For each site in the table, there is a short description that defines its contents. The first table (Table 1) contains uniform resource locators (URLs) involved in directories, catalogs, and library resources (14). In other words, the first table includes website addresses that will help people to find others. These websites are applicable to start understanding the resources available (15). The second table (Table 2) is a list of websites that have more technical information and tools (16). The third table (Table 3) contains databases that allow individuals to search for names and biochemical groups (17). These websites are useful, especially for searching information and properties of biomolecules, including naming, physical properties, structural data, reactive properties, spectral demonstration, and even chromatographic data.

Table 1. Guide to Web and Library Resources

Name	Description	URL
Scirus	For scientific information	http://www.scirus.com/
Intute	Finding the best Web sites for biochemistry	http://www.intute.ac.uk/
BioChem Web	The virtual library of biochemistry, molecular biology, and cell biology	http://www.biochemweb.org
Protocol-Online	Your lab's reference book	http://www.protocol-online.org
University of New Mexico Center for Advanced **Research Computing**	Best biotech sites in the word	http://www.hpc.unr.edu

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The University of Sussex	Chemistry and Biochemistry Library Guide	http://www.guides.lib.ssussex.ac.uk
Iowa State University	Biochemistry library Guide	http://www.lib.iastate.edu
Penn State University	Biochemistry Library Guide	http://www.libraries.psu.edu
Alverno College	Library Resources	http://www.alverno.edu/library

Table 2. Databases and Tools Websites

Name	Description	URL
Protein Data Bank (PDB)	Protein structures determined by X-ray and NMR	https://www.rcsb.org/
European Bioinformatics Institute (EMBL-EBI)	DNA sequencing	https://www.ebi.ac.uk/
National Center for Biotechnology Information	Variety of data and resources	https://www.ncbi.nlm.nih.gov/
Swiss-Protein	Protein sequences and analysis	https://www.expasy.org/resources/uniprotkb-swiss-prot
The Institute for Genomic Research	Collection of genomic databases	https://www.ebi.ac.uk/genomes/
REBASE-The Restriction Enzyme Database	Restriction Enzyme directory and action	http://rebase.neb.com/
NCBI Molecules to GO	Structures of biomolecules	https://pubchem.ncbi.nlm.nih.gov/
PyMol Molecular Viewer	Structures of biomolecules	https://pymol.org/view.html?
Entrez browser of NCBI	Database searching including PubMed literature	https://www.ncbi.nlm.nih.gov/Web/Search/entrezfs.html
Protein Information Resource (PIR)	Database searching for proteins	https://proteininformationresource.org/
Munich Information Center for Protein Sequences	Protein sequences	https://www.helmholtz-muenchen.de/en/helmholtz-zentrum-muenchen/index.html
Name	Description	URL
Journal of Chemical Education	List of all current biochemistry texts	https://pubs.acs.org/journal/jceda8

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Chimera Molecular Modeling System	Advanced molecular modeling	https://www.cgl.ucsf.edu/chimera/
American Society for Biochemistry and Molecular Biology (ASBMB)	Instructional material	https://www.asbmb.org/
ChemDraw	Chemical structure drawing program	https://www.perkinelmer.com/category/chemdraw
MEDLINE (PubMed)	US national library for medicine	https://www.medline.com/

Table 3. Biochemical compound and structure database

Name	Description	URL
International Union Biochemistry and Molecular Biology (IUBMB)	Nomenclature	https://www.qmul.ac.uk/sbcs/iubmb/
IUBMB Enzyme List	Catalog of enzyme	https://www.qmul.ac.uk/sbcs/iubmb/enzyme/
ChemBioFinder	Structures and properties	http://chembiofinder.com/
Worthington Enzyme Manual	Properties of enzymes	http://www.worthington-biochem.com/index/manual.html
Enzyme Database of ExPAsy	Enzymes names and numbers	https://enzyme.expasy.org/
Enzyme Database – BRENDA	A comprehensive enzyme information system	https://www.brenda-enzymes.org/

Removing some websites from the Internet is an annoying aspect of web modification, which also applies to the websites mentioned in this article (18). This process; is sometimes called web rot: when a link breaks down or becomes out of order overtimes, it will occur (19).

If a website adopts a new address, the candidate may be redirected to a new address by entering the previous one (20). Countable numbers of those indicated websites that students need to work or study are listed in the presented tables. However, the new websites may be submitted before this manuscript becomes accepted or printed. Millions of new websites have been being created every year (21). To access these new websites, mostly it is required to have a search engine (a searchable website that categorizes web pages by category) (22). The most frequently used search engines include Google, YouTube, Amazon, Facebook, Microsoft Bing, Baidu, and Yandex (23). During the utilization of a search engine, it is preferred to enter the keyword or phrase you want and then search (24).

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While searching the Internet researcher may come across with websites that need to be stored, so that they can be read in the future gradually (25). Appling the options named Favorites and Bookmarks in most browser software to save the previous findings can be an appropriate choice (26).

Discussion

Application of computer in biochemistry

New computers have revolutionized our lives, and they have restructured our scientific research (27). A computer is an essential tool for studying biomolecules such as structure, activity, reaction, and information (28). The need for computers in biochemical studies and related sciences is devolving for two reasons: A) These fields are becoming more and more quantitative, so they require accurate and complex calculations (computers with access to the Internet, software, and applications are suitable for this purpose) (29). B) To facilitate protein sequencing, and nucleic acid structure determinations, growing biological information has been formed that requires organization, storage, and rapid access for researchers (30).

Initially, computers were used in everyday tasks such as using Microsoft Office software, charting, and statistical analysis of research data (31). However, after the advent of the Internet, it became more widely used, including 1- Searching in biochemical studies, related books, and articles (32); 2- Using software to analyze laboratory data (33); 3- Accessing biological databases that sequence and provide the structure of proteins and nucleic acids (34);

4- Search for research methods, working approaches, and laboratory instructions as well as many other applications (35). Note that the computer application in the analysis, management, and biochemical data possession is referred to as a broad field called computational biochemistry (36). One of the dominant subsets of computational biochemistry is bioinformatics (37), which is practically the use of computers in storing and using biological data, especially in the sequence and structure of proteins and nucleic acids (38). One of the individual's confrontations with the computer in the lab was when using a device that controlled the operation, collection, and analysis of data (39). All required scientific types of equipment, including UV-Visible and fluorescence spectrophotometers, high-pressure liquid chromatography (HPLC), gas chromatography, nuclear magnetic resonance spectrometer, mass spectrometry, and DNA sequencing, are now computer-controlled (40).

Internet access

This article assumes that the reader has access to a computer at work or home. Therefore, mentioning the details of the setup and its use has been omitted. Many of the software programs described in this manuscript are available for free. For writing tasks such as writing lab reports, Microsoft Word is the most popular one (41). Specialized software for scientific and technical writing is also available, but it is not needed at this stage. Available software types for statistical analysis and charting include Excel, Sigma plot, SPSS, and Systat (42). To surf the Internet, each person needs a web browser, which displays web pages (43). In January 2021, according to StatCounter Global Stats website, the most popular browsers were Chrome (63.63%), Safari (19.37%), Firefox (3.65%), Samsung Internet (3.49%), Edge (3.24%), Opera (2.16%), respectively (44).

Biomolecules structure demonstration

Nowadays, determining the structure of biomolecules is one of the regular laboratory activities (45). Thousands of biological findings have been experimentally determined using X-ray crystallography and electron microscopy (46). They are available on well-known websites, introducing protein structures, nucleic acids, and protein-nucleic acid complexes(47). Several useful and accessible websites for reviewing the structure include

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Protein Data Bank (http://www.rcsb.org)
Molecules to Go (http://molbio.info.nih.gov/cgi-bin/pdb)
PyMol Molecular Viewer (https://pymol.org)

The first case is free, but the third one requires registration (48). Academic institutions may pay a subscription fee for part or all of the institutions (49). It means that to obtain a specific structure on such websites, find the main page of the URL and write the biomolecule names you are looking for in the search box. Comprehensive information about the data analysis is provided to readers on each website (50).

Search for biochemical articles

Generating research ideas and maintaining a research laboratory requires extensive knowledge of biochemical articles (51). Many of these articles are available on the Internet, and sometimes you should refer to reference books in the lab as well (52). Biochemistry articles and books are numerous, and their number is increasing rapidly. Maintaining awareness of specialized research in just one field requires an almost full-time effort (53). There is a little demarcation in biochemical studies, and biochemistry articles overlap with biology, physics, medical science, and information technology (54). More resources (books, articles, and websites) will be mentioned to access the information.

Textbooks: Students are first confronted with general biochemistry textbooks for learning and studying biochemistry (55). A comprehensive study of the biochemistry field of science via these books will allow students to build a multi-dimensional insight for understanding biochemistry at each level (56). When a book is published, it is one or two years away from up-to-date information. However, books should still be the primary reference for biochemical concepts (57). Many books are available online these days and are updated by the authors once in a while (58). Besides, a website may be created to publish new content as a supplement to the book (59).

Reference books: The information not suggested in textbooks should be found in reference books (60). There are reference books from general to distinctive ones. Consequently, the best works are multi-volume collections, which have been published over time (61). Each volume usually covers a specific section based on articles by well-known authors in the field (62). It is valuable to know that biochemists often use resources for writing reference books that are not limited to the biochemistry field exclusively (63). One of these journals is named Annual Review of Biochemistry (64). This publishing package contains a great deal of detail, written by experts in each volume from 1932 to the present (64). Meantime, Trend in Biochemical Science (TIBS) journal has received more attention to find shorter review articles that insist on up-to-date topics (65). Active researchers require new methods and techniques frequently (66). Some of the specialized publications on their websites provide details of research methods and many new research methods make the research work smoother (67).

Research journals: The primary part of biochemical resources includes peer-reviewed research journals (68). These articles are essential for the researcher to be up-to-date in their research and even similar fields. These days, countless research journals are published to keep researchers in touch with trendy subjects (69). Some research journals have gained tremendous popularity, and the articles published in them include the highest quality (70). One of the latest rankings of biochemical journals based on the number of citations found is as follows:

Journal of Biological Chemistry (https://www.jbc.org/)
Biochimica et Biophysica Acta (link)
Biochemistry (link1 or link2)
Proceedings of the National Academy …. (https://www.pnas.org/)
Biochemical Journal (https://portlandpress.com/biochemj)
Biochemical and Biophysical Research Communications (link)

Asking a question related to which journal is suitable to use depends on the field of expertise

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(71), and the best way to determine it is through experience (72). According to the scientific information, there is a need to store and use efficient research journals. Most publishers offer magazines online, and libraries charge a subscription fee for the journals they need (73). In this way, professors, students, and researchers can receive the latest free articles (73). If a specific center is not a subscriber of the journal that students need, it is possible to read abstracts of a text on the journal website for free. However, the full text of such a paper; usually needs to be paid (74). Additionally, the site address of such journals can be found using a search engine effortlessly (75).

Conclusions

In conclusion, the fundamental purpose of the provided review is to take a glance at this question of how to solve biochemical problems using computer software? This text presents the internet resources that are referred by various references. In this investigation, each headline provides a rudimentary facet of specific online or offline programs that can be used for various topics. On the other hand, these days, the ability and skills of using the Internet or offline-based software for education and profession is a great advantage, especially for both chemistry and biochemistry students as well as experts at the same time. In the written package, it is tried to introduce preliminary steps toward finding valuable research resources for graduates, and particularly postgraduate students. This paper has illustrated the most accessible collection on the web that is one of the first and crucial elements for an expert candidate in the research laboratory. Furthermore, the manuscript designs a uniform and useful bridge for both elementary students and expert technicians to use raw and analyzed data simultaneously.

Eventually, the texture of this essay is addressing two groups mutually. It started through a simple hobby like web surfing, etc., toward the exclusive activities (gradually) that are a routine for laboratory technicians.

Consequently, it created a proper combination, which can be used as a simple structure involved in enough potential to solve both graduate and post-graduate students' problems.

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