Trainer Resources - Education Summit 2022

Guidelines & Rules:
1. Highlight all changes in pink so that the website owner can copy/paste only changes back into GOBLET website (or use suggesting mode in Google doc)
2. Review yellow highlight fields & add missing content
3. Fix formatting on blue highlight fields

Task Assignment Matrix:

Task	Designate Sign-up	Completed (Y/N)
What skills are needed to be a good trainer? - Check & correct links - Review written text & adjust - Add descriptive text where missing - Add new links - Add keywords per document/link (add as a comment)	Michelle Brazas	Yes
How do I design and develop course/training materials? - Check & correct links - Review written text & adjust - Add descriptive text where missing - Add new links - Add keywords per document/link	Helena Schnitzer	Yes
How can I make my training materials Findable, Accessible, Interoperable, and Reusable (FAIR)? - Check & correct links - Review written text & adjust - Add descriptive text where missing - Add new links - Add keywords per document/link	Celia van Gelder	
How should I organise and facilitate training? - Check & correct links - Review written text & adjust - Add descriptive text where missing - Add new links - Add keywords per document/link	Christina Hall Umar Ahmad	
How should I deliver training? - Check & correct links - Review written text & adjust	Louisse Mirabueno	Yes

- Add descriptive text where missing - Add new links - Add keywords per document/link		

How should I assess trainees?
    - Check & correct links
    - Review written text & adjust
    - Add descriptive text where missing
    - Add new links
    - Add keywords per document/link
    - Add content ideas. Assess learning:
    - For undergraduates:
      https://journals.plos.org/ploscompbiol/article/file?id=10.1371/journal.pcbi.1005872.s002&type=supplementary
    - Some exercises:
      https://www.skillsconverged.com/FreeTrainingMaterials/FullIndexofFreeTrainingExercises.aspx
	Daniel Wibberg	

How do I evaluate a course?
    - Check & correct links
    - Review written text & adjust
    - Add descriptive text where missing
    - Add new links
    - Add keywords per document/link
	Melissa Burke	

How do I endorse and accredit a course?
    - Check & correct links
    - Review written text & adjust
    - Add descriptive text where missing
    - Add new links
    - Add keywords per document/link
	Michelle Brazas	Yes

What should I consider when teaching bioinformatics to high school students?
    - Check & correct links
    - Review written text & adjust
    - Add descriptive text where missing
    - Add new links
    - Add keywords per document/link
    - Add publication year to each entry
	Eija Korpelainen
	Ben Moore	

Where can I find other sources of support?
    - Check & correct links
    - Review written text & adjust
    - Add descriptive text where missing
	Helena	

- Add new links - Add keywords per document/link		
New Section - Resources for Clinical Trainees	Veronika Stoka	I started to complete it
New Section - Resources for General Public	Abdul Alasiri	Yes
New Section - Virtual Training resources		
New Section - Technologies for Training	Celia, Michelle	
Add institutions to entries in Acknowledgements	Michelle Brazas	Yes
Add your name to 2022 Acknowledgements	All 2022 contributors	
Add thoughts on what to do next in 2023		

Trainer Resources

Trainer focus

Resources through life cycle of building and delivering bioinformatics courses and events

Community curated collection

Living document updated annually

Dropdown 1

What skills are needed to be a good trainer?

Just because you are very familiar with a topic, doesn't mean you are necessarily able to teach it well. GOBLET has put together some useful resources for improving skills to become a good trainer. This includes a guidance document for new trainers, links to materials and papers from train-the-trainer (TtT) initiatives and to an online course developed collaboratively by GOBLET, H3ABioNet, ISCB, ELIXIR and EBI Training. Many of the materials are applicable for trainers across a range of disciplines but there is a focus on bioinformatics.

1. A Trainer Guidelines Document was developed at a Bioinformatics Education Summit in 2019 which has a number of useful tips for trainers
2. The key skills and knowledge bioinformatics trainers should have are included in the GOBLET skills matrix
3. Train-the-Trainer courses materials are freely available from ELIXIR, EMBL-EBI, Carpentries and other organizations who offer Train-the-Trainer courses. Courses by many of these providers are advertised on ELIXIR TeSS.
4. Several online courses exist to expand your training skills including:
   a. An EMBL-EBI Online Train-the-Trainer course
   b. Wellcome Connecting Science offers an online Train the Trainer: Design Genomics and Bioinformatics Training
5. Several papers and blogs have been published about Train-the-Trainer courses and resources, these include:
   a. A paper describing the outcomes from the pilot ELIXIR-EXCELERATE Train-the-Trainer programme (2017)
   b. A paper on the pan-European pilot Train-the-Trainer programme (2019)
   c. A paper on the Australian effort to build trainer capacity (2019)
   d. An introductory paper to the Trainer Portal on the GOBLET website (2015)
   e. A global evaluation of the need for bioinformatics trainers (2019)
6. Some general training tips such from the EMBL-EBI User Training Working Group (UTWG) training tips

Dropdown 2

How do I design and develop course/training materials?

GOBLET recommends developing a course with audience, objectives and outcomes in mind. Further, GOBLET recommends using competencies as a framework for course content development. Competencies can also be mapped to existing courses. Below are links to relevant guidelines documents.

Guideline documents

1. Guidelines for developing and updating short courses and course programmes using the ISCB Competency Framework
2. Book – Nicholls, Gill. Developing teaching and learning in higher education. Routledge, 2002.
   Book Description: This book provides an easy and accessible approach to the planning and preparation of teaching sessions, teaching in different settings and teaching across a diverse student population. *Developing Learning and Teaching in Higher Education* is supported by extensive research and provides practical examples of key issues. The book guides the new lecturer through the process of reflection and self-improvement, as well as demonstrating the benefits of producing a portfolio of development.
3. Hamza, Mo. Developing Training Material Guide. Swedish Civil Contingencies Agency (MSB), 2012. (non-competency specific)
   Description: This guide is designed to document the process and good practice in developing training material, piloting and testing it. The guide helps one plan and conduct the course. The guide includes information on the main steps and stages in sequence of designing a training course all the way to evaluation for feedback into further development.
4. The Mastery Rubric for Bioinformatics: supporting design and evaluation of career-spanning education and training (2019)
   a. There is also a recording of a presentation on the Mastery Rubric and its bioinformatics classroom applications from Jessica Lindvall (2021)
5. Course design: Considerations for trainers – a Professional Guide (2020)

Core Competencies for Building Bioinformatics Courses

Using competencies as a framework for course content development can help ensure your content is relevant for the skills needed in the field. Below is a collection of bioinformatics competencies and how they can be used for building a course:

1. ISCB competencies V1 (2014) - This literature provides valuable perspectives on bioinformatics education by defining skill sets needed by bioinformaticians, presenting approaches for providing informatics training to biologists, and discussing the roles of bioinformatics core facilities in training and education.
2. ISCB competencies V2 (2018) - A publication with a set of bioinformatics core competencies, mapping these to ten different user profiles across the spectrum of potential trainees.
3. ISCB competencies V3 - A slide deck "Defining knowledge, skills and attitudes for the

ISCB competency framework"

4. ISCB competency progress reports: First Report (2012), Second Report (2016)
5. NIBLSE competencies (2018)– A publication to serve as a guide for institutions as they work to integrate bioinformatics into their life sciences curricula
6. BioExcel competencies mapped to courses:
   a. View in BioExcel Knowledge Resource Center - Bioinformatics training resources from the Centre of Excellence for Computational Biomolecular Research.
   b. View in Competency Mapper – A web-based tool to support the creation and management of competency frameworks for professionals working in the biomolecular sciences
7. UK National Occupation Standard for Bioinformatics – Drilled down for bioinformatics, the UK National Occupational Standards (NOS) are statements of the standards of performance individuals must achieve when carrying out functions in the workplace, together with specifications of the underpinning knowledge and understanding
8. UK Level 7 Apprenticeship standard for bioinformatics scientists (includes assessment endpoints)
9. CourseSource Bioinformatics Learning Framework (2017)– A publication describing a learning framework for a bioinformatics course that is part of the CourseSource initiative
10. Engineers Australia Stage 1 Competencies – Describes the expectation of the development of the engineer who on graduation satisfied the Stage 1 Competency Standard for Professional Engineer in Australia.
11. A clinical bioinformatics competency framework (2015) to support Health Education England to prepare clinical practitioners for the application of genomics in the healthcare service
12. ISCB Education COSI YouTube collection, especially YouTube video – Implementing a competency-based training strategy for biomolecular researchers with high computational needs

PLEASE NOTE A LARGE AMOUNT OF TEXT WAS MOVED TO NEW DROPDOWN 2B

NEW Dropdown 2B

Where can I find links to bioinformatics Training Materials for courses?

Knowing where to look for curated high-quality bioinformatics training materials can be difficult. We have compiled a list of trusted locations to visit when searching for materials, ideas and other educational resources for teaching on a variety of bioinformatics topics. Repositories/Collections of Training Materials:

1. GOBLET training portal – The GOBLET training portal currently has 3 elements:
   a. Courses and training events, these are shown by TeSS
   b. Training materials, consisting of a section with GOBLET training materials and a section shown by TeSS. A collection of bioinformatics training materials including slide decks and exercises from leading bioinformatics education organizations around the world
   c. Trainer resources - the page you are looking at now.
2. TeSS – the ELIXIR Training Portal. TeSS is a registry that aggregates information about training events and materials from ELIXIR nodes and 3rd-party providers.
3. CourseSource – An open-access journal of peer-reviewed teaching resources for undergraduate biological sciences.
4. The NIH Big Data to Knowledge (BD2K) Training Coordinating Center published an Educational Resource Discovery Index (ERuDite) framework. Search the index for resources here – ERuDIte is the educational resource discovery index that powers the BD2K Training Coordinating Center (TCC) Web Portal.
   a. ERuDIte metadata standards for data science training resources
   b. Publication on ERuDite framework
5. BioExcel Knowledge Resource Centre – Bioinformatics training resources from the Centre of Excellence for Computational Biomolecular Research.
6. NIBLSE Learning Resource Collection – An effort to collect, customize, and disseminate high quality bioinformatics learning resources.

Organization/Institution Specific Collection of Training Materials:

1. UC Davis Bioinformatics Core training collection – Training workshop course materials from UC Davis Bioinformatics data analysis services and training program.
2. Galaxy Training Resources / Network – A collection of tutorials developed and maintained by the worldwide Galaxy community.
3. Bioinformatics.ca Canada – Course materials from the advanced bioinformatics workshops held by Bioinformatics.ca, including slide decks, exercises and data sets.
4. XSEDE Training portal – Training classes and materials to teach users how to maximize their productivity and learn new technologies for using XSEDE services
5. Cornell Virtual Workshops (HPC, programming) – Virtual programming and computing workshops offered by Cornell University
6. PRACE Best practices guide (HPC, MPI) – Best practice guides from the Partnership for Advanced Computing in Europe (PRACE)
7. Rosalind – A platform for learning bioinformatics and programming through problem solving

8. AWS Cloud computing training – Get hands-on practice in a live AWS environment with AWS services and real-world cloud scenarios. Follow step-by-step instructions to learn a service or practice a use case.
9. Google Cloud training labs – Online, self-paced labs give you hands-on practice with Google Cloud technologies in a live environment. Follow step by step instructions to master popular services and real-world use cases.
10. Critical Guides, Professional and Practical Guides in GOBLET Training Portal. Practical guides are for high school students and teachers (see further below in the High school section, Professional Guides are for trainers and Critical Guides give introductory lessons about main bioinformatics tools & services.
11. F1000 Research Bioinformatics Education & Training Collection – This collection is dedicated to publishing content (e.g., papers, slides, posters, reports or other documents) relating to bioinformatics and data science training and education

Dropdown 3 (celia to clean up)

How can I make my training materials Findable, Accessible, Interoperable, and Reusable (FAIR)?

The Bioinformatics Training community has embraced the idea of 'FAIR' for training materials in order to widen their quality, accessibility and reach. Below we have linked to resources on metadata best practices to enable you to FAIRify your training materials.

Bioschemas

xxx

Bioschemas Training Portal

      a. Bioschemas what and why
      b. Bioschemas Training Profiles
          i. Training Material
          ii. Course (Draft)
          iii. Course Instance (Draft)
      c. Bioschemas Profile Markup Generator [Training profiles COMING SOON]

Metadata and Ontologies

xxx

1. EDAM Ontology browser for categorizing and annotating your training:
2. Recommendations for a minimal metadata set to aid harmonised discovery of learning resources (Version 1.0). Research Data Alliance (2022)

FAIR training materials

xxx

1. ELIXIR FAIR Training Focus Group - This Focus Group aims to implement FAIR principles in training (FAIR: Findable, Accessible, Interoperable and Reusable). The group contains members from ELIXIR and from the international community.
2. Ten simple rules for making training materials FAIR (2020) -
3. Checklist for depositing training materials into Zenodo

Dropdown 4 (celia to clean up)
How should I organise training?

Good course organisation is just as important as the quality of training materials. We regard "course organisation" as all the aspects the organizer has to put in place before and after the actual training event . A training organiser is responsible for the smooth running of a training event from conception to completion. Depending on the format and design of your training event, this may include, but is not limited to: course program development, budgeting, travel logistics, advertising, management of applications, venue booking and event management.

Here's a list of templates and best practices to help you create a well organised training event.

1. The comprehensive H3ABioNet Training Guide is a collection of relevant templates you can edit and use for your own workshop organisation. The Guide's documents include templates for schedules, announcements, timelines, logistics, airline bookings, Host bids, budgets, applicant selection, travel award letter, name-tags, Certificates of attendance / completion, participant & faculty biographies, and photo consent forms. A separate archive containing the original templates is also available.
2. The Carpentries Handbook: Teaching and Hosting
3. Australian BioCommons has also published a checklist and collection of templates for hybrid bioinformatics training events.

A code of conduct is a set of rules outlining the normal practices, responsibilities and expectations of course organisers, trainers and trainees. Ensuring that all parties have an understanding of the code of conduct allows the creation of an inclusive, safe and respectful learning environment for everybody. Code of conduct examples are:-
1. ISCB Code of Conduct
2. Bioinformatics.ca Code of Conduct
3. EMBL Code of Conduct
4. Galaxy Project Code of Conduct

Dropdown 5
How should I facilitate and deliver training?

A well-delivered training event is just as important as good training materials. As a trainer, you are responsible for delivering the course effectively. You are likely to have been involved in the programme development, decisions around workshop format, as well as the creation of course materials. There are a range of workshop formats and teaching styles that have been successfully employed in a number of different environments. Below, GOBLET has compiled a collection of relevant examples, templates and best practices to help you when you are preparing to deliver training:

1. Information about different styles of classrooms:
    a. A blended training model:
        i. The Past, Present and Future of Blended Learning: An in Depth Analysis of Literature (2014)
        ii. Case study: "Designing a course model for distance-based online bioinformatics training in Africa: The H3ABioNet experience" (2017)
    b. Applying project-based learning (2017)
    c. Online versus classroom-based learning (2014)
    d. Computational biology flipped classroom (2018)
2. Best practices documents:
    a. The Carpentries Handbook: Teaching and Hosting
    b. Serving Life-science information for the Next Generation (SLING) (2012)
    c. Best practices in bioinformatics training for life sciences (2013)
    d. GOBLET bioinformatics training best practices workshop (2018)

3. Using group discussions during training:
    a. Strategies for group discussions
    b. Effective group discussions
4. Template for creating hands-on practicals including how to include code in your material
5. Technologies to use in the classroom:
    a. Slack – is a communication and task management tool. It can be used in the classroom together with a learning management system to encourage communication between course participants.
    b. An extensive list of technologies and software platforms to support virtual training environments and communication
6. How to use the cloud, VMs and containers in bioinformatics training:
    a. ELIXIR Workshop on how to use clouds and virtual machines (VMs) (2017) in bioinformatics
    b. Slides from a workshop on using containers in training (2016)

Dropdown 6 (celia to clean up)
How should I assess trainees?

Knowing how to appropriately assess trainees can be challenging. Resources below are intended to shed some light on this. <mark>MAKE CLEAR THE RELATION WITH/ DIFFERENCE WITH DROPDOWN 7 (EVALUATION)</mark>

Make structure

1. Assessment : What students think (Future learn)
2. Monitoring learner progress (Brown, 1999)
3. Using Bloom's taxonomy to assess learning outcomes (1956 / 2001)
4. How Do IBCT Trainers Evaluate Their Trainees? (2018)
5. Assessing an effective undergraduate module teaching applied bioinformatics to biology students **(2018) -**
   To assess how students respond to the use of bioinformatics as a central requirement for data analysis in a biology class, the module started with a 31-item questionnaire plus some questions about student demographics. After completing the four-week module, students were given a postmodule questionnaire that contained the same questions as the first questionnaire (except for the part asking about demographics), plus a number of questions about student perception of the usefulness of the module for their future career.
6. The Four Best Ways To Assess Your Trainee's Learning **(2019)**
7. What is the difference between formative and summative assessment (2019)
8. An assessment plan (2018) is a document that outlines the student learning goals to be assessed during the term, a brief description of the assessment methods including the sources of data and intervals at which the data will be reviewed. These plans can also be used to outline which individuals will be responsible for carrying out these tasks. Assessment plans refer to an activity that faculties or departments undertake at the beginning of their assessment cycle timeframe, which is generally the academic year. As such, the planning process starts in late summer. An assessment plan should be finalized in the fall semester in order to allow for adequate time for educators to implement the plan.
9. An assessment report is essentially an extension of the assessment plan. Sometimes departments or programs use one document that serves as both the plan and the report. The majority of the document is completed during the planning process, and once data has been collected, reviewed, and discussed, the reporting components are then completed.

Dropdown 7
How do I evaluate a course?

Collecting demographics and evaluating the quality and impact of a course can assist in improving and/or strengthening future training. Be consistent in the data that you collect for all of your training courses to help comparison of different training courses and collation of statistics for reporting.

There are three different types of information that can be collected. When deciding which demographics or feedback to collect, consider those you require in order to produce training statistics and reports:

1. **Training statistics and audience demographics** - Typically collected during or directly after a course using a survey or registration form and used in reporting.

   Collected information may include:
   1. Contact information
   2. Organisation
   3. Gender
   4. Career stage
   5. Employment sector (e.g. academia vs industry)
   6. Skill level

   Resources for collecting statistics and demographics:
   1. Carpentries Assessment and Impact Surveys - A catalogue of pre-, post- and long-term workshop surveys used to evaluate training on data and coding skills provided by the Carpentries Community

2. **Feedback on the quality of the course** - Typically collected immediately after a course using a feedback survey and used in course improvement.

   Feedback questions may include:
   1. Overall rating for specific sections and/or course overall
   2. Questions that ask about aspects of the course - e.g., length, organisation, materials, access, support
   3. A score or question about how does this course compare to others you have attended
   4. Free text questions to capture suggestions and candid feedback - e.g., What was the best part of the course? What could be improved?

   Resources and case examples for collecting course quality feedback:
   1. A framework to assess the quality and impact of bioinformatics training across ELIXIR (2020) - Outlines ELIXIR's strategy for collecting short and long term feedback from bioinformatics training courses across Europe
   2. Carpentries Assessment and Impact Surveys - A catalogue of pre-, post- and long-term workshop surveys used to evaluate training on data and coding skills provided by the Carpentries Community

3. Feedback, Reviewing and Improving STEM Activities – An online course on how to improve your STEM activities by learning how to obtain and use feedback in the classroom effectively.
4. 5 Elements to Include in any Post Training Evaluation - A short blog post exploring 5 elements to incorporate in training evaluation: effectiveness, comprehension, attractiveness, engagement and suggestions.
5. Student evaluations of teaching (mostly) do not measure teaching effectiveness (2016) - Discusses how gender biases and stereotypes influence responses to feedback surveys using examples from France and the US.

3. **Feedback on the impact of the course on participants work** - Typically collected in the long term (e.g., 6 months to 1-2 years after training; in 6 month intervals)

This qualitative feedback is designed to assess whether the course has resulted in changes in behavior. Feedback questions may include:
1. Did the skills learned in the course improve your ability to conduct your research?
2. Did the skills learned in the course lead to a publication?
3. Did the skills learned in the course assist with workplace research communications?
4. Did the skills learned in the course lead to career advancement?

Resources and case examples for collecting course impact feedback:
1. 10 simple Rules for Measuring Impact of Workshops (2018) - Describes 10 simple strategies for improving the evaluation of workshops from designing surveys, dealing with bias, what to ask and gamification.
2. Continuing Education Workshops in BioInformatics Positively Impact Research and Careers (2016) - Provides example questions, reflections and tips on administering long term impact surveys based on experience evaluating courses run by Bioinformatics.ca in Canada.
3. Carpentries Assessment and Impact Surveys - A catalogue of pre-, post- and long-term workshop surveys used to evaluate training on data and coding skills provided by the Carpentries Community
4. Research Infrastructures' Impact Assessment Toolkit - This toolkit is designed to help people assess the impact of research infrastructures on the economy and contribution to society.
5. Using core competencies to evaluate course impact [COMING SOON]

Dropdown 8 (celia to clean up)
How do I endorse and accredit a course?
Endorsement is intended to provide a process by which one can have a well-established body like ISCB certify that the course meets the standards for an education program in the domain of computational biology and bioinformatics.

There are in general, 2 main types of COURSES that could be endorsed:

1. Bioinformatics **short-course** (TRAINING course of hours to one or two weeks in length)
2. Bioinformatics **degree course** (ACADEMIC course of two weeks to a term in length)

WHY would one want to endorse and affiliate a **short-course**:

- Public and international recognition of the course as being evaluated and positively associated with the ISCB
- Course providers gain additional exposure of their training to a highly relevant audience worldwide
- ISCB members gain access to a carefully selected catalogue of courses, and discounted rates to some courses
- ISCB is able to provide additional member benefits such as advertising

WHY would one want to endorse and accredit a **degree course**:
- Public and international recognition of the course as being evaluated and positively associated with the ISCB
- Course providers gain additional exposure of their training to a highly relevant audience worldwide
- ISCB student members can have a clear worldwide collection of educational institutions and universities that provide good quality courses on Bioinformatics

1. [Application process](#) for ISCB Endorsement & Affiliation of a short-course
2. Application process for [ISCB Endorsement & Accreditation of a degree course](#)

DELETE Dropdown 10 (celia to clean)

Where can I find other sources and support?

Big Data Biomedicine and Education – rationale for doing bioinformatics training (2016)

Envisioning the Future of 'Big Data' Biomedicine – The National Institute of Health (NIH) 'Big Data to Knowledge' programme (BD2K), 2017

Selection of the 10 rules papers

Report on surveys about bioinformatics training needs

        a. A Global Perspective on Evolving Bioinformatics and Data Science Training Needs (2019)

        b. Unmet Needs for Analyzing Biological Big Data: A Survey of 704 NSF Principal Investigators (2016)

        c. Survey of bioinformatics and computational needs in Australia 2016

A good Example of a Biomedical Data Science Webinar Series

NEW Dropdown 9
Where can I learn about Technologies used in Training?

Bioinformatics training is highly dependent on technologies for in-class communications and general setup of training events. This is compounded with the recent shift to virtual training events. The available technologies are continually evolving and trainers are constantly retooling to improve their training events. The following collection of technologies is not exhaustive, so if a useful technology is missing, please send us your suggestion using the contact on the Missing a Resource page.

General technologies to facilitate bioinformatics training include:
1. Cloud computing - is an option when local compute environments are unavailable for training or when the training requires more compute than is available locally. Some emerging content overviewing cloud computing and some experiences using cloud computing in training include:
   a. An Introduction to cloud computing from DataCarpentry
   b. Developing and Implementing Cloud-Based Tutorials That Combine Bioinformatics Software, Interactive Coding, and Visualization Exercises for Distance Learning on Structural Bioinformatics (2021)
   c. Development of a cloud-based Bioinformatics Training Platform (2017)
   d. Organizing and running bioinformatics hackathons within Africa: The H3ABioNet cloud computing experience (2019)
   e. ERuDIte Resources related to cloud training
   f. Applying for AWS cloud credits for education
2. Virtual machines and containers like Docker and Kubernetes - ready-to-run virtual machine (VM) images containing an operating system and pre-installed analysis software, as well as containers, are gaining momentum in bioinformatics. These images and containers can be run on multiple compute platforms including cloud platforms, which allows easy scaling for running tens or hundreds of simultaneous jobs in a course setting.
   a. How to set up a VM - A nice simple overview of VMs is provided by ITCS Finland
   b. How to set up a Docker container [COMING SOON]
   c. How to set up a Kubernetes container [COMING SOON]
3. GitHub - Learn how to build GitHub pages/wikis/websites for courses/training materials
4. Jupyter Notebooks - [COMING SOON]
5. Pros and Cons of various technologies used in training from Education Summits 2020 & 2021

NEW Dropdown 10
What resources are available for training the General Public?

These educational materials are intended to spark general public interest in science, and help them learn more about genomics and bioinformatics.

1. What is bioinformatics?
2. Educational Resources of the National Human Genome Research Institute (NIH)
3. Explain Bioinformatics to Your Grandmother! (2013)
4. A Quick Guide to Genomics and Bioinformatics Training for Clinical and Public Audiences (2014)
5. What is bioinformatics and how do we use it?
6. Bioinformatics facts for kids
7. OMGenomics
8. Is Computational Biology the answer to our health problems

Dropdown 11

What should I consider when teaching bioinformatics to high school students?

When teaching bioinformatics at high school level, one should consider the curriculum and the language that is being used as this might be useful in deciding the content and level of standard.

Existing High School Teaching Materials

1. GOBLET Practical Guides
   a. Bioinformatics – the Power of Computers in Biology: A Practical Guide (2019)
   b. Using Bioinformatics to Understand Genetic Diseases: A Practical Guide (2019)
   c. Introducing computer-aided drug design – a practical guide (2020)
   d. Bioinformatics – Food Detective: a Practical Guide (2020)
   e. Using bioinformatics to hunt SARS-CoV-2, its variants & its origins – a practical guide (2021)
2. mGen – An online and mobile app for promoting engagement between high school learners and research staff
3. SEA-PHAGES Bioinformatics Guide – An online Bioinformatics guide to turn a new phage genome sequence into a refined annotation
4. European Learning Laboratory for the Life Sciences (ELLS) – Resources for teachers and students
   a. ELLS TeachingBase – A collection of molecular biology teaching modules designed for teachers and students
   b. The NODE – a community site for and by developmental biologists
5. TReND – scientific training using low-cost open source tools and model systems for scientific research
6. ISCB Collection of Bioinformatics Resources for High School – a collection of resources from the International Society for Computational Biology
7. NAVIGENE – It is a navigation tool developed for biology teachers at secondary schools. You can use it in class to design lessons on genomics, genes and proteins.
8. Bioinformatics@school – Bring bioinformatics to the classroom with free online educational modules and information on bioinformatics (from the Netherlands). Three specific lessons are: Murder at the airport, Designing an antivenom and Losing sight and vision
9. GenSCOP genetics app – a student-led project from the Sydney Brenner Institute for Molecular Bioscience (SBIMB) and Wits Human Genetics Community Outreach Program. The app is designed as a library containing simple explanations of genetic concepts.
10. Bioinformatics: Coding for Medicine – See how the worlds of computer scientists and medical doctors are merging together through a set of courses that give young students the right skills to contribute to this fast-changing scientific world. NOTE: Only some content is free
11. Whitehead, Bioinformatics and Research Computing (BaRC) – A collection for learning about bioinformatics and computational tools
12. ~~Teaching – Student projects – Bornberglab – Bioinformatics at the IEB~~
13. Scientix is a project, funded by the Horizon 2020 framework of the EU for research and

innovation, that promotes and supports a Europe-wide collaboration among STEM (science, technology, engineering and mathematics) teachers, education researchers, policymakers and other STEM education professionals. Scientix has a [Moodle](#) with courses, [webinars](#), and a [blog](#). The blog post "[Didactic research in High School for innovative STEM bioinformatics activities](#)" describes what bioinformatics is and why it is important to teach it in high schools.

14. ~~How to design an anti-inflammatory drug without side effects for the stomach? – Interesting high school student bioinformatics activity~~

15. 4273π – A freely available, customized distribution of Raspbian GNU/Linux for the Raspberry Pi computer. 4273π is for those wishing to teach, learn or use bioinformatics on the Raspberry Pi.

Relevant papers and materials on bioinformatics in the high school classroom

1. Integrating bioinformatics into senior high school: design principles and implications (2013) – Here the authors present design principles of bioinformatics learning environments for high schools, and an integrated tool they developed which uses authentic inquiry based learning activities.

2. Bioinformatics in High School Biology Curricula (2008) – This study evaluates the representation of bioinformatics related content in secondary school science standards in 40 US states and district of Columbia ~~(2007)~~

3. Bioinformatics Education in High School: Implications for Promoting Science, Technology, Engineering, and Mathematics Careers (2017) – This paper ~~(2017)~~ investigates the effects of a specific Bio-ITEST teacher professional development programme and bioinformatics curricula on awareness, engagement, self-efficacy and relevance in high school teachers and students to boost the interest in STEM careers.

4. Explaining Genomics and Bioinformatics to High School Biology Students – Describes an inquiry based learning activity for high school students, that also includes a short history of genomics and bioinformatics and their main applications as well as the relevancy to students' lives.

5. Ten Simples Rules for Teaching Bioinformatics at the High ~~Secondary~~ School Level (2011) ~~PLoS Comput Biol 7(10)2011~~ –Experienced high school science teachers give ten tips on how to incorporate bioinformatics in science curricula.

6. ~~Teaching High School Biology: Materials and Strategies – Overview on how the high school biology programs at the precollege level should be adapted to meet the aspirational needs and projections for the future of youth in a changing society.~~

7. ~~Ten Simple Rules for Teaching Bioinformatics at the High School Level – Experience of a high school science teacher on how to incorporate bioinformatics in high school classrooms given the number of topics and tools allowing interactive instruction.~~

8. Bringing Bioinformatics into the Biology Classroom – Slides from the SIB (Swiss Institute of Bioinformatics) introducing how bioinformatics basic resources can handle disease-related questions

9. ~~Kids.Net.Au – Encyclopedia > Bioinformatics – An introduction to Bioinformatics and examples of its most widely used applications~~

10. Bioinformatics for middle school aged children (2008) – Enhancing teacher knowledge

and confidence to integrate innovative instructional materials into K-8 classrooms and contributes to capacity building in STEM instruction

11. Academic Kids – Bioinformatics – The major research areas related to Bioinformatics are presented, including associated software tools and very useful links.
12. RRI-tools for Responsible Research and Innovation (many useful links included) – A reflection on how innovative pedagogical methods in STEM teaching can help introduce RRI principles in schools to foster STEM careers attractiveness.
13. Science education policies in the European Commission: towards responsible citizenship (2015) – With the priority given to connect science to society under the EU projects umbrella, this article presents key aspects and objectives of "responsible" science education in Europe.

NEW Dropdown 12

What resources are available for training Clinical Audiences?

These educational materials are emerging content to engage with clinical audiences to help them learn more about genomics and bioinformatics.

An excellent starting point is the paper A Quick Guide to Genomics and Bioinformatics Training for Clinical and Public Audiences (2014).

Additional papers which focus on the clinical audience include:
1. Course-based undergraduate research experiences in molecular biosciences-patterns, trends, and faculty support (2017)
2. Using 'collective omics data' for biomedical research training (2018)
3. A Bioinformatics Crash Course for Interpreting Genomics Data (2020)
4. A global perspective on evolving bioinformatics and data science training needs (2019)
5. Clinical bioinformatics for microbial genomics and metagenomics: an ESCMID Postgraduate Technical Workshop (2020)
6. An Open-Source Toolkit To Expand Bioinformatics Training in Infectious Diseases (2021)
7. A good Example of a Biomedical Data Science Webinar Series

NEW Dropdown 13
Forums and Networks of Trainers and Organizers

Several international bioinformatics education and training focused communities exist to provide support, additional resources and comradery. Joining one of these communities is highly encouraged!

1. GOBLET – The Global Organisation of Bioinformatics Learning, Education and Training
2. LifeSciTrainingSlack - A slack community to connect anyone and everyone who does training in the life sciences to share resources, advice, and conversation - all in the service of improving teaching and careers.
3. ISCB Education COSI - ISCB Community of special Interest where to get information about bioinformatics education, to start discussion on relevant topics and get connected to other like-minded people.
4. ISCB Education Committee - promotes worldwide education and training in computational biology by providing guidance and support for educational resources and community activities.
5. The Community of Practice for Training Coordinators (CoP) is an informal network to share training experiences initiated by a group of people who coordinate training programmes in research domains and e-infrastructures.
6. Education Summit group. A virtual working group that meets at a hands-on meeting once per year and continues task activity throughout the calendar year.
7. Big Data to Knowledge (BD2K) - NIH program that supports the research and development of innovative and transformative approaches and tools to maximize and accelerate the utility of big data and data science in biomedical research. The group outlines their vision in a publication: Envisioning the Future of 'Big Data' Biomedicine (2017)

NEW Dropdown 14

Key Publications

The global community has collaborated to publish several key publications and to establish several key collections of publications relevant to bioinformatics training.

Bioinformatics training needs
1. A Global Perspective on Evolving Bioinformatics and Data Science Training Needs (2019)
2. Unmet Needs for Analyzing Biological Big Data: A Survey of 704 NSF Principal Investigators (2016)
3. Survey of bioinformatics and computational needs in Australia (2016)

Collections of Education-focused Publication
1. PLOS Computational Biology - Education section
2. F1000 Research Bioinformatics Education and Training Collection

Dropdown 15

Suggest a New Section or Resource

If you are looking for a resource that you cannot find here, or if you would like to suggest a resource, please contact us at info@mygoblet.org

Dropdown 16
Acknowledgements

The GOBLET Trainer Resource Portal has been pulled together over time by the following individuals:

Education Summit, Capetown 2019

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What to do next in 2023?

List your thoughts on how the Trainer Resources portal could improve. These will be considered at the next Education Summit in 2023.

- User testing/survey to see if it is useful and organized correctly. Have a feedback button? Or with a small Gform? We can send it actively to our networks too.
- Write-up (poster, paper) for Trainer Resources Portal
- Spend more time on new sections from 2022: Public Audience Resources, Clinical Audience Resources, adding explanations of what you can find in each link (This TED talk describes…)
- Are there similar trainer resources available in other languages?
- [GOBLET] Can the web portal add user feedback on the resources?
- Option: have a session at GOBLET AGM to let the participants check the pages and give feedback. AGM is 11-14 October 2022.
- Create a process for trainers to make such trainer documents sustainable, DOI, PDF
- Topics for next iteration:

    - How to build GitHub pages/wikis/websites for courses/training materials [COMING SOON]
    - Where can I learn about Technologies for Virtual Training?
    - How to provide e-learning?

Next Steps from 2022
~~Clean document (Celia & Michelle)~~
     ~~Due date: June 30, 2022~~
~~Circulate to group for feedback (All Education Summit session participants)~~
     ~~Due date: Monday July 4, 2022~~
~~Final clean up (Celia & Michelle)~~
     ~~Due Date: Monday July 11, 2022~~
~~Pass to GOBLET for updating website~~