**AL-FARABI KAZAKH NATIONAL UNIVERSITY**

**Faculty of Medicine and Social Healthcare**

***Higher School of Medicine***

**Department of Fundamental Medicine**

**METHODOLOGICAL INSTRUCTIONS FOR PRACTICAL LESSONS**

**by the discipline** **«Omics technologies in medicine and pharmacy»**

**(5 credits)**

**Seminar 1*.* Introduction to “Omics” technologies.**

*Maximal point: 10*

1. Explain, how you understand the term "Omics" technologies? Give the definition of this term.

2. Describe the main Omics technologies, their methods and the connections between them.

3. Describe the application of Omics technologies in medicine and pharmacy, their perspectives in the Future.

**Seminar 2. Structural genomics. Human genome.**

*Maximal point: 10*

1. Give the definition to the following terms: "gene", "genotype", "genome", "genetics" and "genomics".

2. Characterize the differences between structural and functional genomics, give the definitions.

3. Describe the history of the Human Genome Project. What is the meaning of this project?

4. Analyze the applications of the results of this project in medicine and farmacy, their future perspectives.

5. Briefly describe the structure of human genome.

**Seminar 3.** **Functional genomics.**

*Maximal point: 10*

1. Give the definition to the following terms: functional genomics, genome organization, informational capacity of the genome, informational density of the genome.

2. Characterize the different types of genes by their functions, give the specific examples.

3. Explain how the human genome encodes 100 thousands proteins if it contains only 25-30 thousands of genes?

4. Compare the genomes of several absolutely different organisms with the human genome by their structure and informartional properties, analyze the differences and similarities.

5. Describe the mechanisms of gene expression: transcription, post-transcriptional modyfications, translation and post-translational modyfications of proteins.

**Seminar 4. Epigenomics.**

*Maximal point: 10*

1. Explain the difference between the terms “genetics” and “epigenetics”, “genomics” and “epigenomics”.

2. Explain the term “gene expression” and different mechanisms of inheritance.

3. Describe the mechanisms of gene expression regulation on the transcriptional and post-transcriptional level in procaryotes and eucaryotes.

4. Characterize the histone modifications and their influence on gene expression.

5. Explain the mechanisms of environmental influence on gene expression.

**Seminar 5.** **Farmacogenomics.**

*Maximal point: 10*

1. Explain the difference between the terms “farmacogenetics” and “farmacogenomics”.

2. Characterize the mechanisms of genetically based human reactions to the medical drugs, give the specific examples.

3. Describe the methods of farmacogenomics.

**Colloquium 1**

*Maximal point: 50*

**Seminar 6. Genomic methods of research and diagnostics.**

*Maximal point: 10*

1. Analyze Sanger and Maxam-Gilbert methods of DNA sequencing.

2. Compare Sanger method with several methods of Next Generation Sequencing (NGS), analyze their advantages and disadvantages.

3. Describe “short gun-sequencing” and “chromosome walking” methods of genome sequencing.

4. Characterize bioinformatical methods of genome analysis (genome assembling, genome annotation, finding of open-reading frames (ORFs) and prediction of genes, alignment of nucleotide sequences, protein structure prediction and etc.). Give specific examples of used programs and bioinformatical databases.

5. Explain the main traditional methods of molecular biology that are used in genomic research: polymerase chain reaction (PCR), gel-electrophoresis, northern blotting, Southern blotting, restriction analysis and etc.

6. Describe the methods of DNA genotyping, DNA diagnostics, DNA fingerprinting and DNA microarray.

**Seminar 7.** **Transcriptomics. Methods of transcriptome investigation.**

*Maximal point: 10*

1. Give the definition to the following terms: “transcript”, “transcriptome”, “transcriptomics”, “gene expression profile”.

2. Describe and analyze the different types of RNA by their structure and functions.

3. Explain the methods of different RNA extraction, amplification and sequencing.

4. Explain how the methods of gene expression profiling, RNA microarray and RNA-seq can be used for diagnostics of different diseases?

**Seminar 8. Proteomics and methods of proteome investigation.**

*Maximal point: 10*

1. Give the definition to the terms “olygopeptides”, “polypeptides”, “proteins”, “proteome”, “proteomics”.

2. Explain and analyze the experimental methods of proteomics: MALDI-mass-spectrometry, ESI-mass-spectrometry, different types of chromatography, 2D- and 3D-PAGE, ELISA, nuclear magnetic resonance (NMR), X-ray diffraction and etc. What are the reasons for selecting any of these methods for specific proteins?

3. Describe the computational (bioinformatical) methods of protein research: amino acid sequence alignment, protein structure prediction, analysis of X-ray diffraction pattern and 3D-modelling of protein structure.

4. Characterize the Protein Data Bank (PDB), Uni-ProtKB/Swiss-Prot and other bioinformatical databases of protein information.

**Seminar 9.** **Interactomics (the research of protein-protein interactions).**

*Maximal point: 10*

1. Give the definition to the terms “interactome” and “interactomics”.

2. Characterize the experimental methods of interactomics: yeast two-hybrid system (Y2H-assays), phage display, solid phase affinity chromatography, molecular fishing on the chip of optical biosensor, mass-spectrometry and microscopic methods. Give the specific examples.

3. Analyze and compare the bioinformatical methods of interactomics: phylogenetic trees, interaction networks and etc.

**Seminar 10. Glycomics.**

*Maximal point: 10*

1. Give the definitions to the following terms: “carbohydrates”, “monosacharids”, “disacharids”, “polysacharids”, “glycome” and “glycomics”, give the specific examples.

2. Analyze the chemical structure and fuctions of different carbohydrates, give the specific examples.

3. Describe the chemical structure and function of glycoproteins and proteoglycans.

4. Explain how some glycoproteins (lectins) can participate in cellular recognizing, adhesion and interactions between the cells (so called “sugar code”)?

5. Explain different disturbances of carbohydrate metabolism and methods of their diagnostics and treatment, give the specific examples.

**Colloquium 2**

*Maximal point: 50*

**Seminar 11.** **Lypidomics.**

*Maximal point: 10*

1. Give the definition to the terms “lipids”, “lypoproteins”, “lypidome”, “lypidomics”.

2. Analyze the different types of lypids by their chemical structure and function, give the specific examples.

3. Explain the methods of lypidomic research.

4. Explain different disturbances of lypid metabolism and methods of their diagnostics and treatment, give the specific examples.

**Seminar 12. Regulomics and metabolomics.**

*Maximal point: 10*

1. Give the definition to the terms “metabolites”, “metabolism”, “regulome”, “regulomics”, “metabolome”, “metabolomics”.

2. Explain the mechanisms of enzyme activity regulation, give the specific examples.

3. Briefly describe the metabolism of all organic and non-organic substances in human organism (metabolism of proteins, carbohydrates, lypids, minerals, salts and water) and its regulation (hormonal, neural and biochemical).

4. Characterize the methods of research the metabolism.

5. Explain how metabolic disturbances diseases connected with different human diseases, give the specific examples.

**Seminar 13.** **Bioinformatics.**

*Maximal point: 10*

1. Explain the terms “bioinformatics”, “computational biology” and “system biology”.

2. Analyze the bioinformatical methods used in different “Omics” technologies, give the specific examples.

3. Explain the differences between structural, functional and evolutional bioinformatics.

4. Give and describe the examples of bioinformatical computer programs used for different tasks.

5. Classify and describe the main bioinformatical databases, give the specific examples.

**Seminar 14. Personalized medicine (the future of medicine).**

*Maximal point: 10*

1. Give the definition to the terms “personalized medicine”, “gene therapy”, “target delivery”, “nanoparticles”, “nanotechnology”.

2. Explain how the omics technologies can be used for individual diagnostics, treatment and profilactics of human diseases?

3. Analyze the modern and future methods of biomedicine used for treatment of human diseases (nanotechnology, biocompatible polymers, artificial tissues and organs, using the stem cells, radiation oncology and etc.). What are their dangers and perspectives?

4. Characterize the methods of gene therapy “*ex vivo”* and *“in vivo”*, give the specific examples.

5. Analyze the perspectives and dangers of human genome editing, its bioethical consequences.

**Seminar 15.** **The development of new drugs by using the omics technologies.**

*Maximal point: 10*

Explain the each step of the drug development by using different “omics” technologies, give the specific examples.

**Colloquium 3**

*Maximal point: 40*

**ISW**

*Maximal point: 10*

Passing the free online-course “Drug discovery” of the University of California, San Diego, on the website Coursera.

**Methodical directions for seminars**

**The goal:** to get in-depth knowledge of "Omics" technologies used in medicine.

**Expected outcomes of all seminars:** 

1. to have an idea of the modern "omics" technologies;
2. correctly choose one of the research methods for solving the stated experimental and theoretical problems;
3. describe “proteomics”,
4. highlight signs and draw conclusions on protein microchips, etc.;
5. classify "Omics" technologies in the context of clinical diagnosis;
6. to find the relationship between omics technologies and personalized medicine;
7. demonstrate knowledge of the use of omix technologies;
8. describe a group of monogenic and multifactorial diseases;
9. understand the methods for obtaining and analyzing experimental data.

**Plan of preparation work for each seminar**

1. Familiarize yourself with the basic and additional literature, use textbooks, the syllabus and present directions, Internet resources to prepare for seminars.

2. Be prepared for class and participate actively on case-discussion and problem solving group activities.

3. Use the examples (in this number cases and your own experience studied before) for illustration of theoretic material.

4. Use different tools for studying, discussion and visualisation of thoughts - drawing, mind maps, 3D-modelling.

5. Use the group work with cases for the development of teamwork skills, communication, problem solving and self-studying.

***Marks for practical lessons (seminars)***

|  |  |
| --- | --- |
| **Topic** | **Max. point** |
| 1 | 2 |
| Seminar 1. Introduction to “Omics” technologies. | 3 10 |
| Seminar 2. Structural genomics. Human genome. | 3 10 |
| Seminar 3. Functional genomics. | 3 10 |
| Seminar 4. Epigenomics. | 3 10 |
| Seminar 5. Farmacogenomics. | 33              10 |
| Seminar 6. Genomic methods of research and diagnostics. | 3 10 |
| Seminar 7. Transcriptomics. Methods of transcriptome investigation. | 7 10 |
| Seminar 8. Proteomics and methods of proteome investigation. | 10 |
| Seminar 9. Interactomics (the research of protein-protein interactions). | 3 10 |
| Seminar 10. Glycomics. | 10 |
| Seminar 11. Lypidomics. | 3 10 |
| Seminar 12. Regulomics and metabolomics. | 10 |
| Seminar 13. Bioinformatics. | 10 |
| Seminar 14. Personalized medicine (the future of medicine). | 10 |
| Seminar 15. The development of new drugs by using the omics technologies. | 10 |

**SEVERAL TIPS ON TEAM WORK AND TRANING[[1]](#footnote-1)**

The medical profession involves working in multidisciplinary teams, so these skills are identified as key in the competence of the doctor and other health professionals in all countries.

Therefore, group work is included as an essential component in the practical exercises of our course. In addition, it aims to provide a safe environment in which you can try out new ideas and practices and acquire relevant group skills. These can be tasks for performance in pairs, triples or small groups of 4-6 people (work with cases, tasks of the ISW, etc.).

When you are working on a project or task in a team, you have the opportunity to use the various strengths of the group members to create a wider and better project or task than if you were working independently.

Group training means you need to share your knowledge and ideas with other students. There are two benefits to this: you need to think carefully about your own ideas in order to explain them to others, and you expand your own understanding, taking into account the knowledge and ideas of others.

**Interpersonal Communication and Discussion**

Take some time to chat and get to know each of your group mates. The better you know each other and the more convenient you communicate, the more effective you can work together.

Create a culture of mutual respect in your group. You probably had little choice or no choice at all when forming training groups and small teams in the classroom. Therefore, you will have to learn to overcome the differences between people. In addition, you will not have the opportunity to choose employees in the workplace, and at work, you will experience much greater pressure to be a productive member of the team.

For effective communication and discussion in a team: you should not be shy to express your opinion and it is important to feel that these opinions will be heard; it is necessary to feel that all members of the group make a feasible contribution to solving problems, observing agreed rules and plans, performing work efficiently and on time; it is important to know that everyone’s feelings are taken into account by team members, but the goals and objectives of the group are not compromised, in favor of the whims or desires of individual members;

Try to express your opinion and listen to others. There is nothing wrong with disagreeing with your classmates, no matter how confident they are. When you disagree, be constructive and focus on the problem, not the person. Similarly, when someone disagrees with you, respect what he says and the risk that he takes upon himself to express his opinion. Try to find a way that everyone can agree with, and this is not necessarily the opinion of the loudest or smartest member of the team.

Below we provide some examples of constructive and destructive group behavior[[2]](#footnote-2)

**Constructive group behavior** - a person who:

***Unites*** - interest in the views and opinions of others and willingness to adapt to interest

***Clarifies*** - clearly defines the problems for the group by listening, summarizing, focusing the discussion

***Inspires*** - encourages the group, stimulates participation and progress

***Harmonizes*** - stimulates group unity and teamwork. For example, uses humor as a relaxation after difficult situations.

***Take the risk*** - willingness to take risks at the expense of oneself for the success of the group or project

***Manages the process*** - organizes a group on the issues of the process: for example, plan, schedule, timeline, topic, solution methods, and use of information

**Destructive group behavior:**

***Domination*** - takes a lot of time expressing your opinion and views. Trying to take control by capturing energy, time, etc.

***Fussiness*** - hastens the group to move quickly before the task is completed. Impatient in listening to other opinions and working together.

***Suspension*** - removes itself from a discussion or decision. Opt out

***Ignoring*** - does not respect or belittle the ideas and suggestions of the team or individuals. An extreme manifestation of ignoring is an insult in the form of ridicule.

***Distraction*** - excessive talkativeness, tells stories and leads groups away from the goal

***Blocking*** - prevents group progress by denying all ideas and suggestions. “It will not work because ...”

Effective group work does not arise by itself. A conscious and planned effort is needed, and since many people participate in it, one cannot rely on memory; need to make notes. **The following steps** will help you and your team work together effectively.

***1. Define clear objectives.*** At each stage, you should try to coordinate the tasks. They include a timeline for the project, as well as more specific tasks (such as “agree on an approach to the task before Friday”). Each meeting or discussion should also begin with a specific goal (for example, make a list of tasks that need to be completed). Tasks should be broken down into smaller parts and planned. Sometimes one part cannot be started until the other part is finished, so you may need to draw a simple temporary map.

· discuss the resources that you have and those that you will need to find.

· formulate the desired result.

· consider how you know when you did it well enough?

· split tasks between the team and

· set deadlines for subtasks and time for future meetings.

***2. Set the basic rules.*** Discussions can become erratic and can prevent more modest group members from participating if you do not have rules to stimulate discussion, resolve disagreements, and make decisions without repetition. Set the rules from the start and change them as needed. For example: an interesting rule that was developed by one group - anyone who missed a meeting would buy the rest of the group coffee in a coffee shop. No one ever missed a meeting after that.

***3. Communicate effectively.*** Make sure you regularly communicate with group members. Try to be clear and positive in what you say without repeating.

***4. Find consensus.*** People work together most effectively when they work towards a goal with which they have agreed. Make sure everyone has their own opinion, even if you need time to get more participants to say something. Make sure you listen to everyone’s ideas and then try to come to an agreement that everyone shares and everyone has contributed.

***5. Define the roles.*** Divide the work that needs to be done into separate tasks, for which you can use the strengths of individual team members. Define roles for both fulfilling your tasks and for meetings / discussions (for example, Arani is responsible for summarizing the discussions, Joseph is for everyone to express their opinions and make decisions, etc.).

Examples of roles and functions:

*Facilitator* or *leader* (depending on context) - to clarify the goals of the meeting and to summarize the discussions and decisions; ensures that the meeting takes place, continues and the basic rules are respected.

*Secretary* - keep a record of the ideas discussed and decisions made and who does what.

*Time Manager* - to make sure that you discuss everything that you need in the time allotted for the meeting.

*Controller* - to ensure that work is completed by an agreed time, and to solve problems if they are not being performed.

*A process observer* is someone who monitors the process, not the content, and can bring problems to the attention of the team. In this role, it is important to be positive, not condemning.

*Editor* - bring all materials together, identify gaps or matches and ensure consistency in the final presentation.

***6. Make it clear.*** When a decision is made, it should be explained in such a way that it is absolutely clear to everyone that it was decided, including the time frame.

***7. Keep good notes.*** Always summarize the discussions and document the decisions and publish them (for example in WhatsApp chat) so you can always get back to them. This includes lists of those who agreed what to do.

***8. Stick to the plan.*** If you agreed to do something as part of the plan, do it. Your group relies on you to do what you agreed to do, and exactly in this way, not in the way you would like. If you think the plan should be reviewed, discuss it.

***9. Keep track of progress and keep up to date***. Discuss progress together regarding your schedule and deadlines. Make sure you meet deadlines personally so you do not let your group down.

**Co-writing a document / report**

Joint writing is one of the most difficult parts of group work. There are many ways to do this, and your group must decide how to separate the work of writing, comparing, editing, and finalizing your work. Writing in a group (six people crowd around the keyboard) is a recipe for conflict and lack of progress. The other extreme - when one person assumes all responsibility and ultimately does most of the work - is also unproductive and contributes to conflict.

Three approaches are possible when working on a common document:

1 - One person writes the most part - this means that a narrow circle of ideas is used, and the rest of the team does not learn (and will not learn) to write reports and documents.

2 - Each person writes one section - then it is difficult to make a single consistent report, and you will not know about the rest, except for your own section.

3- Co-writing. This is the most productive way to solve group problems and provides the greatest benefit from collaboration. For example: in each section, there is a writer and at least one reviewer, and each team member is the author of a section and a reviewer of another one.

All team members before finalization by **the editor** must review the final product. Alternatively, you can have one author with others, editors, add and review, and someone tidies the finished report.

Try to divide the writing of source documents into tasks and solve them individually or in pairs. After the first draft of the sections are written, send out all the components and read them. You will probably need to come together to discuss how to combine them so that they fit together. Any participants who were not involved in preparing the drafts can do part of this work. Then edit, improve and polish the draft. It’s convenient to collaborate on documents in Google documents.

When preparing a report / final document, regularly check the following:

- Is the purpose of the project clear from the report?

- Are the conclusions or recommendations clear?

- Do conclusions follow from the main part of the report?

- Do sections fit well?

- Does the report achieve goals (and evaluation criteria)?

- Are the necessary components sufficiently covered?

Whatever method you use, all group members must agree on the process and how they are going to maximize the collaborative approach to writing the final document.

**Monitoring team performance and coping**

Below is a checklist that includes a list of common problems that arise in a group work. Use it regularly to identify problems before they get out of hand. If serious problems and tensions arise, use it to determine where something might go wrong. First answer each question about yourself, and then give answer to this **question** about the group as a whole. Then gather a group and discuss where, in your opinion, problems may arise, and think about how you can overcome these problems.

Each participant must complete this checklist. You should do this exercise regularly to track and improve your team’s performance.

1. Answer each question regarding your teamwork.

2. Answer each question regarding the rest of the team.

3. Get together with your entire team and discuss where, in your opinion, any problems arise.

4. Discuss what you are going to do to overcome these problems.

**Checklist for self-assessment of team effectiveness.**

|  |  |  |  |
| --- | --- | --- | --- |
| You | I personally | Group as a whole | Comments |
| Effectively clarify your tasks and tasks at each stage? |  |  |  |
| Evaluate the progress of work? |  |  |  |
| We clarify and document everything that the group decided? |  |  |  |
| We clarify who will do what and how? |  |  |  |
| We clarify by what date each task should be done? |  |  |  |
| Setting meeting management rules? |  |  |  |
| Adhere to agreed rules? |  |  |  |
| Listening to each other? |  |  |  |
| Allow some team members to dominate? |  |  |  |
| Allow some team members to refuse / withdraw? |  |  |  |
| We sacrifice personal desires for the success of the team? |  |  |  |
| Recognize the feelings of other team members? |  |  |  |
| Making equal contributions to team progress? |  |  |  |
| Adhere to agreed rules for writing and naming files? |  |  |  |

**Points and Grade**

Group tasks and assignments mean that grades are given to the whole group based on the results of the work of the whole group. Everyone should be interested in ensuring the effective contribution of all members of the group and ensuring the high quality of the assignment. Sometimes, to assess the relative contribution of each to the group process, a form of peer-to-peer or peer review and a team assessment form will be used. This can be used to moderate assignment grades, or simply as a way to give feedback on your work in a group. The following are examples of student assessment criteria for team training.

|  |  |
| --- | --- |
| **№** | **Student assessment criteria in practical classes** |
| 1 | *Preparation for classes:*  He studies information focused on the case and problematic issues, uses various sources, and supports the statements with relevant links. |
| 2 | *Group skills and professional attitude:*  Demonstrates excellent attendance, reliability, responsibility Takes the initiative, takes an active part in the discussion, helps the teammates, willingly takes on tasks |
| 3 | *Communication skills:*  Actively listens, shows emotions according to the situation, is susceptible to non-verbal and emotional signals, shows respect and correctness in relation to others, helps to resolve misunderstandings and conflicts |
| 4 | *Feedback Skills:*  Demonstrates a high level of introspection, critically evaluates oneself and colleagues, provides constructive and objective feedback in a friendly manner, accepts feedback without opposition |
| 5 | *Skills of critical thinking and effective learning:*  Effectively participates in generating hypotheses and formulating problematic questions, gives relevant examples from life, skillfully applies knowledge to the problem / case under consideration, critically evaluates information, draws conclusions, explains and substantiates statements, draws diagrams and drawings, demonstrates a constant interest in the material being studied |
| 6 | *Theoretical knowledge and skills on the topic of the lesson:*  All key aspects are presented logically; accuracy, relevance of answers to the questions posed without redundancy; integration of theoretical issues; Use of relevant examples proper use of professional terminology |

**Basic literature**:

1. Mambetpayeva, B. S. Basics of Biomedicine: training aid / B. S. Mambetpayeva ; Ministry of Health of the Republic of Kazakhstan. - Astana : Ақнұр, 2017. - 197 p. - URL: http://elib.kaznu.kz/order-book. - ISBN 978-601-7894-91-7

2. Beketayeva, Assel Orozalievna. Mathematical Modeling of the Biomedical Processes : study book / A. O. Beketayeva ; Al-Farabi Kazakh National University. - Almaty : Qazaq University, 2018. - 106 p. : il. - URL: http://elib.kaznu.kz/order-book. - Bibliogr. at the end of sections. - 100 (circulation) экз. - ISBN 978-601-04-3730-2

3. Vlahou et al. Integration of Omics Approaches and Systems Biology

for Clinical Applications / 2018 John Wiley & Sons, Inc. – 382 p.

4. Yu Liu. OMICS in Clinical Practice / 2014 by Apple Academic Press, Inc. – 456 p.

5. Barh D., Blum K., Madigan M.A. OMICS. Biomedical Perspectives and Applications / 2012 by Taylor & Francis Group, LLC. – 516 p.

**Additional literature:**

1. Clark, David P. Biotechnology: Applying the Genetic Revolution : textbook / D. Clark, N. Pazdernik. - Amsterdam ; Boston ; Heidelberg : Elsevier, 2009. - 762 p. - URL: http://elib.kaznu.kz/order-book. - ISBN 978-0-12-175552-2

2. Nanobiotechnology: inorganic Nanoparticles vs Organic Nanoparticles / Instituto de Nanociencia de Aragon-ARAID, Universisdad de Zaragoza ; ed. by J. M. de la Fuente, V. Grazu. - Amsterdam ; Boston ; Heidelberg : Elsevier, 2012. - 520 p. : il. - (Frontiers of Nanocience. Vol. 4). - URL: http://elib.kaznu.kz/order-book. - Ind.: p. 509-520. - ISBN 978-0-12-415769-9

3.Zhussupova, Aizhan Izbasarovna. PCR – Diagnostics : educational manual / A. I. Zhussupova ; Al-Farabi Kazakh National University. - Almaty : Qazaq university, 2016. - 127, [1] p. - URL: http://elib.kaznu.kz/order-book. - Bibliogr.: р. 124. - ISBN 978-601-04-1237-8

**Internet resources:**

1. Lecturio.com

<https://www.lecturio.com>

2. Taylor and Francis Online

<https://www.tandfonline.com/action/doSearch?AllField=omics&SeriesKey=iedc20&pageSize=10&subjectTitle=&startPage=0>

3. “Human Genome” Project <https://web.ornl.gov/sci/techresources/Human_Genome/project/info.shtml>

4. NCBI - The National Center for Biotechnology Information, USA <https://www.ncbi.nlm.nih.gov/>

5. NDB - a portal for three-dimensional structural information about nucleic acids <http://ndbserver.rutgers.edu/>

6. OMIM - compendium of human genes and genetic phenotypes <https://www.ncbi.nlm.nih.gov/omim?db=OMIM>

7. Ensembl - Genome browser for vertebrate genomes <http://asia.ensembl.org/index.html>

8. EMBL-EBI - European Bioinformatics Institute

<https://www.ebi.ac.uk/>

9. Video lectures by Molecular Biology:

<https://www.khanacademy.org/>

10. Coursera

<https://www.coursera.org/>

1. adapted from UNSW Guide to Group Work <https://student.unsw.edu.au/groupwork>) [↑](#footnote-ref-1)
2. adapted from Brunt (1993): <https://tle.wisc.edu/solutions/engagement/constructive-and-destructive-groupbehaviors> [↑](#footnote-ref-2)