Student Directed Seminar Proposal

1. Seminar Content & Rationale (between 200 – 500 words)

In 2000, the world saw the first draft of the human genome, which Bill Clinton described as "learning of the language in which God created life". Fast forward to 2012, a team of talented researchers led by Jennifer Doudna and Emmanuelle Charpentier harnessed the power of CRISPR-Cas9 technology to edit the genomes faster, cheaper and more efficient than ever, allowing humans "to rewrite" the language in which the life was created. One might imagine that this discovery was bound to revolutionize the fields of medicine, synthetic biology and many more. However, it cannot be overlooked that the powers of the greatest tools have the potential to be misused by the individuals who although academically educated, lack ethical reasoning. In 2018, a Chinese biophysicist He Jiankuia announced that he had used the CRISPR gene-editing system to edit DNA in human embryos to make them less susceptible to HIV. He had performed this unnecessary and, most importantly, severely unethical procedure in pursuit of fame and profit.

There is a plethora of genetics-oriented courses offered by UBC, all of which introduce the new exciting technology and how it works, but none of them, unfortunately, discuss the ethical implications that come with the use of this technology. It is always assumed that the student will implement an ethical and fair practice in their research, but, as evidenced by the recent events, that is not always the case. As a future generation of aspiring scientists and potential policymakers, I think it is imperative that we understand the responsibilities that come with the cutting-edge technology that we are using or implementing anew. I hope that after taking this seminar, the students that are hoping to center their career around genetics will fill this gap of knowing how to use the technology, but not being aware of when not to use it.

The academic focus of this seminar will be centered around learning about new and exciting technologies and research regarding genetic engineering, followed by ethics-based discussions of associated inherent issues with the tools. In this peer discussion-based class, students will have the opportunity to inspect the current problems related to genome manipulations from a variety of different angles, as they will hear many opinions from their fellow students, and learn how to integrate all the genetics knowledge they gathered in other classes with the principles of justice and equity.

2. Seminar Structure and Plans (between 1-2 pages)

I propose this seminar to be held twice a week for 90 minutes. I think 90 minutes is an optimal class time, since students tend to lose focus after very long lectures (even 90-minute classes could be hard to follow sometimes, not to mention the 3-hour ones). Therefore, I believe that 50-minute lecture/30-minute discussion would be a great distribution of class time – enough time spent learning new material without losing focus, followed by revising the topics by sharing opinions with the classmates for the remaining class time. The lecture portion would consist of students' presentations (they would pick 2 topics at the beginning of the term that they would like to present) or a guest speaker's lecture, when introducing a major lecture section (a lecturer that will introduce the notion of ethics, another one that will acquaint the students with the

concept of genetic engineering, etc.); remaining lecture time will be used to discuss the material with the class, where students can share their opinions on the topic in question.

I intend to provide a coursework plan, that depicts the course topic and the respective assignments, as well as to facilitate and be a part of a discussion in a self-learning setting. I also hope that I will able to engage some professors from various departments (Philosophy, Biology & Zoology, Medical Genetics, Biomedical Engineering, etc.), that will be able to share their insight with the students, as well as provide perspective of how individuals from different backgrounds view the same issue. I'm very passionate about both the genetics and the ethics of it, so I hope that my enthusiasm will be translated to the classroom and I will be able to assist the class in the learning process. I intend to support the group and make the best out their learning experience by sending them reminders about the assignment dates, learning their interests and trying to integrate them into the discussion topics and creating a positive emotional climate (create an icebreaker at the beginning of the classroom, so the students know each other's names, interests and backgrounds; use name cards, so people in the class can address each other by their names, which creates a more positive learning space (this will also make me learn their names faster); implement semicircle seating, if possible, so the class members can see each other).

Firstly, since it will be a small class (less pressure on speaking up) and it is not mandatory to take, only the students truly interested in the topic would be inclined to join the class, so I believe that they will be interested in sharing their opinions on the matter. I will do my best to keep the topics of the class compelling, thought-provoking and up to date with the recent scientific discoveries, which will minimize the overlap with their other genetics-based classes and will keep the class engaged and focused. I also hope to implement some presentation projects for the class, which will reinforce the"self-learning"part of it, and dedicate a small portion of their grade towards participation (~10% of the whole term, you get a point each class if you asked or answered a question during the period), which will elicit a discussion. Also, there are a lot of techniques that could be used to initiate a discussion more effectively: I could make a list of key points from the discussion, which will provide the students with some starting points for the discussion; I could ask students to work in pairs/smaller groups before they share their opinions with the class, as it is easier to express opinions, when talking to a single person, rather than a whole classroom; it's only normal that some students are shy and don't want to participate in the discussion at first, but I think it is important that their voice should be heard as well – writing down opinions on the notecards could be a less stressful activity, so I could ask them to write down what they think on a given topic and then collect the cards, and address them as a class, so everybody's opinions are heard and people feel included.

The very first class will be an introduction of the topic (genetic engineering) and addressing the ethical gaps. I will introduce myself and the Faculty Sponsor and then move to the icebreaker, so the students fill more comfortable with each other (this will help with productive discussion further in the class). I will then introduce the course format and syllabus, so we can select the seminar topics as a class – this will help shape the course for that specific class cohort, which will hopefully maximize their engagement and interest. I will introduce some basic general ethics to the classroom and ask them what they know about it themselves. In the next class of the week one, I will ask students about the genetic engineering tools that they know and how they work, and whether they are aware of any policies regarding these technologies (we will discuss some of those), we will talk briefly about the history of genetic engineering and we will discuss some of the basic ethical principles of science (1) informed consent, (2) return of results,

and (3) privacy and confidentiality on the example of HeLa cells (and how they failed in the past). This will serve as a good introduction to ethics of science to the classroom, and help the students get an understanding of how we will spend our class time usually.
The next week (week 2), I plan a bioethicist guest lecturer, that will introduce what they research and talk about policy-making and the importance of ethics discussion in science, this will set a stage for why it is important for the students to take the class. Another guest lecturer could come at the beginning of the third week, which will refresh the students' knowledge of what genetics is (what genes/genomes are, what is chromatin, how genes are expressed, somatic vs germline mutations, etc.).Though I plan to set BIOL 335 (Molecular Genetics Class) as a prerequisite, I think it is still important to remind the students about some basic genetics, so they do not get confused as we move on to more advanced topics. This will be followed by the discussion of direct-to-consumer genetic testing (23andMe, AncestryDNA, etc.): do they know what this is? Will they take part in it (why or why not)? Do they think it is a good or unnecessary service?

A schematic plan for the 13-week schedule is included AT THE END of this application.

Week	Section	Topic	Reading/ Activity	Learning Objective(s) / Purpose	Assignments
1	Genetic Engineering around us	Introduction to the class topics	- Icebreaker	- Introduce the syllabus to the students - Finalize the syllabus & grading scheme based on student feedback and interests	- Participation marks (PM)
2	Genetic Engineering around us	Introduction to Ethics + Ethics in Science & Policymaking	- YouTube Video: What is ethics? (https://www.youtube.com/watch?v=VI-t0eWp9WA) - Reading: "Nursing ethics: across the curriculum and into practice" by Karen L. Rich – Chapter 1 (pp. 3-28), Introduction to Ethics (https://samples.jbpub.com/9781449649005/22183_CH01_Pass3.pdf) - Guest lecturer for Policymaking & Ethics in sciences (contact Michael Burgess, David Friedell)	- Introduce students to the basics of ethics - Why science ethics matter during policymaking	- PM
3	Genetic Engineering around us	Introduction to Genetic Engineering + CRISPR	- Reading #1: "Basic Genetics" by Bruce Korf (pp. 461-468), (http://www.sld.cu/galerias/pdf/sitios/genetica/genetica_basica.pdf) - Reading #2: "Genetic Engineering and Moral Responsibility" by Bruce Small (https://www.intechopen.com/books/genetic-engineering-basics-new-applications-and-responsibilities/genetic-engineering-and-moral-responsibility) - History of Genetic Engineering (https://www.synthego.com/learn/genome-engineering-history) - YouTube Video: Genetic Engineering Will Change Everything Forever – CRISPR (https://www.youtube.com/watch?v=jAhjPd4uNFY&t=22s)	- Refresh students' basic knowledge of genetics - Learn about the history of Genetic Engineering - Familiarize students with the ongoing methods of genetic engineering & discuss the inherent issues & limitations of these techniques	- Presentations - PM

3. Seminar Grading and Evaluation (between 300 – 500 words)

- **Participation** (ask or answering question once per lecture, I will keep track of that for every student in a tabulated form) – 10%
- **Oral Presentation 1** (students will select a topic from the provided list, and present it to the class, mark is given based on the peer evaluation) – 15%
- **Oral Presentation 2** (tudents will select a topic from the provided list, and present it to the class, mark is given based on the peer evaluation) – 20%
- **Essay on the movie/docuseries**, discussing the topic of genetic engineering (the students can either select the movie "GATTACA", or docuseries "Unnatural Selection") – 20%
- **Book Club Discussion** (students are going to vote on which book we're going to read "Never Let Me Go" by Kazuo Ishiguro/ "Oryx and Crake" by Margaret Atwood, and we're going to dedicate a whole class period to discussing how human genetic engineering was problematic in these books) – 10% (for actively participating in the discussion)
- **Book Club Essay** – 10%
- **Case Project** (student will be given an ethics scenario related to genetic engineering, and they will have to design and defend an argument of what is ethically permissible/impermissible for a person to do in a given scenario) – 15%

⇒ [Example case: Ella and Derek are in their 30s and are planning to have a baby → Derek has always been fascinated with the blue color of Ella's eyes, and now they're planning to go to a clinic that can make the baby have the blue-eyed eyes with the help of assisted reproductive technologies → The baby's health will not be affected by them having blue eyes at all → Do you think it is morally permissible for them to genetically engineer their baby to have blue eyes? Why or why not?]

The thought-provoking nature of the seminar facilitates higher-level thinking by itself; there is not really a wrong or right answer for these questions and it's not simply a "yes" or "no" answer. The students' objective isn't to simply remember and understand the material, but to "evaluate and create" – they learn how to apply the information into an innovative way, forming their own opinions and arguments. Most of the assignments are focused on assessing student's ability to think (essays, case projects, class discussions), rather than retain information, which I believe to be the ultimate goal of an upper-level classes – development of higher order thinking skills (analyzing, synthesizing, applying). Thus, I think this class has a suitable evaluation scheme to maintain academic rigor.

4. Student Recruitment & Selection (100 – 200 words)

I think a variety of students with different backgrounds would be interested in taking the seminar – especially science students enthusiastic about genetics and arts students with a strong background in ethics. I anticipate a high demand for this class, since I've talked with a number of my peers (both having a science background and non-science related disciplines) and a lot of them were genuinely interested in taking the class.

I intend to have a BIOL 335 prerequisite, since this is the course, where students get exposed to the concept of genetic engineering and relevant techniques, meaning the student will have a solid foundation prior to entering the class. However, I'm willing to override the prerequisite for some of the students, if I see a strong interest in taking the class in their statement of intent. Given that, I will ask all of the students to write a short statement of intent before enrolling, but I would recommend students without the prerequisite to compose a longer statement, which will outline why they want to take the class, what background knowledge they have (they might know a lot about genetic engineering without taking the class, while doing research on their own!), and the strategies they will take to make up for their gaps in knowledge. I would be looking for the following things in the students: passion for the subject, positive attitude, ability to learn independently. I'm hoping to position the class within BIOL department.

SUPPLEMENTARY READING LIST FOR **THE POTENTIAL TOPICS** – *ETHICS OF GENETIC ENGINEERING*

Week/Session	Part/Theme/ Section	Topic	Reading/ Activity	Learning Objective(s) / Purpose	Assignment/Assessment Criteris
1	Genetic Engineering around us	Introduction to the class topics	- Icebreaker	- Introduce the syllabus to the students - Finalize the syllabus & grading scheme based on student feedback and interests	- Participation marks (PM)
2	Genetic Engineering around us	Introduction to Ethics + Ethics in Science & Policymaking	- YouTube Video: What is ethics? (https://www.youtube.com/watch?v=VI-t0eWp9WA) - Reading: "Nursing ethics: across the curriculum and into practice" by Karen L. Rich – Chapter 1 (pp. 3-28), Introduction to Ethics (https://samples.jbpub.com/9781449649005/22183_CH01_Pass3.pdf) - Guest lecturer for Policymaking & Ethics in sciences (contact Michael Burgess, David Friedell)	- Introduce students to the basics of ethics - Why science ethics matter during policymaking	- PM
3	Genetic Engineering around us	Introduction to Genetic Engineering + CRISPR	- Reading #1: "Basic Genetics" by Bruce Korf (pp. 461-468), (http://www.sld.cu/galerias/pdf/sitios/genetica/genetica_basica.pdf) - Reading #2: "Genetic Engineering and Moral Responsibility" by Bruce Small (https://www.intechopen.com/books/genetic-engineering-basics-new-applications-and-responsibilities/genetic-engineering-and-moral-responsibility) - History of Genetic Engineering and the Rise of Genome Editing Tools (https://www.synthego.com/learn/genome-engineering-history) - YouTube Video: Genetic Engineering Will Change Everything Forever – CRISPR (https://www.youtube.com/watch?v=jAhjPd4uNFY&t=22s)	- Refresh students' basic knowledge of genetics - History of Genetic Engineering - Familiarize students with the ongoing methods of genetic engineering & discuss the inherent issues & limitations of these techniques	- Presentations - PM

4	Genetic Engineering around us	GMO + synthetic biology	- Phillips, T. (2008) Genetically modified organisms (GMOs): Transgenic crops and recombinant DNA technology. Nature Education 1(1):213 (https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/) - Weale, A. (2010). Ethical arguments relevant to the use of GM crops. New biotechnology, 27 5, 582-7 .	- Define what is GMO and synthetic biology - What are the current applications of these technologies - Outline inherent problems associated with these technologies	- Presentations - PM
5	Genetic Engineering around us	Gene drive + Malaria	- News feature: Self-destructing mosquitoes and sterilized rodents: the promise of gene drives (https://www.nature.com/articles/d41586-019-02087-5) - Collins J. P. (2018). Gene drives in our future: challenges of and opportunities for using a self-sustaining technology in pest and vector management. BMC proceedings, 12(Suppl 8), 9. https://doi.org/10.1186/s12919-018-0110-4 - Watch *Unnatural Selection* episode about Gene Drive	- What is Gene Drive? - Identify potential misuses of this technique	- Presentations - PM
6	Genetic Engineering around us	ES Cells and iPS Cells	- Yee, J. (2010) Turning Somatic Cells into Pluripotent Stem Cells. Nature Education 3(9):25 (https://www.nature.com/scitable/topicpage/turning-somatic-cells-into-pluripotent-stem-cells-14431451/) - Zacharias, D. G., Nelson, T. J., Mueller, P. S., & Hook, C. C. (2011). The science and ethics of induced pluripotency: what will become of embryonic stem cells?. Mayo Clinic proceedings, 86(7), 634–640. https://doi.org/10.4065/mcp.2011.0054	- What are the differences between ES and iPS cells? - Identify potential applications of these technologies - What are some potential problems associated with these technologies	- Presentations - PM

7	Human Genetic Engineering	Biohacking	- Bennett, G., Gilman, N., Stavrianakis, A. et al. From synthetic biology to biohacking: are we prepared?. Nat Biotechnol 27, 1109–1111 (2009). https://doi.org/10.1038/nbt1209-1109 - Watch *Unnatural Selection* episode about Biohacking	- What is Biohacking? - Why could it be problematic?	- Presentations - PM - **Essay for GATTACA/Unnatural Selection**
8	Human Genetic Engineering	International Summit on Human Gene Editing + Genome as property	- Understanding ownership and Privacy of Genetic Data (http://sitn.hms.harvard.edu/flash/2018/understanding-ownership-privacy-genetic-data/) - Francis L. P. (2014). Genomic knowledge sharing: A review of the ethical and legal issues. Applied & translational genomics, 3(4), 111–115. https://doi.org/10.1016/j.atg.2014.09.003	- Is genetic information considered a private property? - What are some policies that are implemented to protect one's genetic information? - Outline some ethical issues with owning one's genome	- Presentations - PM
9	Human Genetic Engineering	Cloning Technology	- Ayala F. J. (2015). Cloning humans? Biological, ethical, and social considerations. Proceedings of the National Academy of Sciences of the United States of America, 112(29), 8879–8886. https://doi.org/10.1073/pnas.1501798112	- What is cloning? - Outline some of the ethical issues inherent to this technology	- Presentations - PM
10	Human Genetic Engineering	Ethics of Assisted Reproductive Technology: PDG vs genetic engineering (selecting vs perfecting), Designer Babies + Eugenics	- Eisenberg, V. H., & Schenker, J. G. (1997). Genetic engineering: moral aspects and control of practice. Journal of assisted reproduction and genetics, 14(6), 297–316. https://doi.org/10.1007/bf02765833 - TED talk: The ethical dilemma of designer babies | Paul Knoepfler (https://www.youtube.com/watch?v=nOHbn8Q1fBM) - "Genetically Modified Babies – Ethical Issues Raised by the Genetic Modification of Germ Cells and Embryos" by the Ethics Committee of Quebec (https://www.ethique.gouv.qc.ca/media/1038/cest_modif_gene_resume_an_acc.pdf)	- What's the difference between PGD and genetic engineering? - What is eugenics? - What are some inherent issues of "designer babies"? - Disabilities vs Genetic Engineering	- Presentations - PM

			- What are the Ethical Concerns of Genome Editing? https://www.genome.gov/about-genomics/policy-issues/Genome-Editing/ethical-concerns		
11	Human Genetic Engineering	Human-Animal Hybrids	- News feature: Japan approves first human-animal embryo experiments (https://www.nature.com/articles/d41586-019-02275-3) - Dietmar Hübner, Human-Animal Chimeras and Hybrids: An Ethical Paradox behind Moral Confusion?, The Journal of Medicine and Philosophy: A Forum for Bioethics and Philosophy of Medicine, Volume 43, Issue 2, April 2018, Pages 187–210, https://doi.org/10.1093/jmp/jhx036 - Kwisda, K., White, L. & Hübner, D. Ethical arguments concerning human-animal chimera research: a systematic review. BMC Med Ethics 21, 24 (2020). https://doi.org/10.1186/s12910-020-00465-7	- What are human-animal hybrids? - What are the current policies for creating human-animal hybrids - What are the inherent issues associated with human-animal hybrid creation?	- Presentations - PM - **Book Club Discussion** & **Essay**
12	Human Genetic Engineering	Gene therapy – CAR-T cells & LUXTURNA	- Intro to Biotechnology: Techniques and Applications. Unit 3 – Gene Therapy (https://www.nature.com/scitable/ebooks/cntNm-16570330/126470698/) - Hunt, S. (2008) Controversies in treatment approaches: Gene therapy, IVF, stem cells, and pharmacogenomics. Nature Education 1(1):222 - Penticuff, J. (07/1994). Ethical issues in genetic therapy Lippincott Williams and Wilkins. doi:10.1111/j.1552-6909.1994.tb01911.x	- What is gene therapy? - What are some FDA approved gene therapies? - Outline ethical issues associated with gene therapies - Somatic vs Germline Gene Therapy	- Presentations - PM
13	Human Genetic Engineering	Gene enhancement & Gene doping	- Filipp, F. Is science killing sport? *European Molecular Biology Organization Reports* **8**, 433–435 (2007)	- What is gene doping? - What are the current policies regarding gene doping?	- Presentations - PM

			- Well, D. J. Gene doping: The hype and the reality. *British Journal of Pharmacology* **154**, 623–631 (2008) doi:10.1038/bjp.2008.144 - Greene, M., Master, Z. Ethical Issues of Using CRISPR Technologies for Research on Military Enhancement. Bioethical Inquiry 15, 327–335 (2018). https://doi.org/10.1007/s11673-018-9865-6 - Macpherson, I., Roqué, M. V., & Segarra, I. (2019). Ethical Challenges of Germline Genetic Enhancement. Frontiers in genetics, 10, 767. https://doi.org/10.3389/fgene.2019.00767 - Robert Sparrow (2019) Yesterday's Child: How Gene Editing for Enhancement Will Produce Obsolescence—and Why It Matters, The American Journal of Bioethics, 19:7, 6-15, DOI: 10.1080/15265161.2019.1618943	- Outline ethical issues associated with gene toping and gene enhancement - Somatic vs Germline Gene Therapy - Gene therapy vs Gene Enhancement - Problem of Obsolescence	- **Case Project** due during finals period