

BIOL 351 | Genetics in Practice; Decoding the Language of Life **Fall 2026**

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Course Description

- Have you ever considered why genetic tests have become increasingly important in recent years in the diagnosis, prognosis and treatment of certain diseases such as hereditary diseases, hematological neoplasms (e.g. leukemias) or viruses' infections?
- Have you ever wondered how prenatal and postnatal genetic screening helps in the identification of genetic syndromes allowing early medical intervention when needed?
- Do you know how chromosomal abnormalities affect infertility and miscarriages and how they contribute to informed reproductive choices?
- Have you ever tried to find how environmental genotoxic exposure induces DNA damage and cancer?
- Have you ever thought that a new genetic engineering technology can allow precise modifications of DNA to correct genetic defects with potential applications in the treatment of genetic diseases?
- Do you know how DNA profiling is used in crime investigation, determining the biological father of a child and in cases where victims are unidentified due to decomposition, natural disasters, or war?
- Can you imagine how the knowledge of our genetic profile can enable positive lifestyle adjustments so as to influence subjective well-being?

In this course we will address these and many other questions. The current course focuses on human Genetics and its applications in human life. We will cover a variety of genetic applications from medicine to social life.

Genetic material in the form of DNA or chromosomes constitutes the language of life. Genetic tests have become increasingly important in recent years in the diagnosis of certain hereditary diseases or other multifactorial diseases contributing to prevention, early diagnosis and/or treatment selection of patients (e.g. personalized medical treatment, gene therapies). This course is relevant to wider social contexts as people's genetic information is increasingly being used for a wide range of non-clinical purposes, such as crime investigations and determining paternity.

The aim of the course is students to familiarize themselves with Genetics and its applications in human life, especially in current medical practice and research but also in society. Moreover, to understand how genetic variations influences our social behavior, educational attainment and our health. The course is adapted to be understandable to all the students regardless the field of their studies. Non previous knowledge is required.

Course approach

This course will be held at the campus of NCSR "Demokritos", which is the largest research center in Greece. Course topics will be explored mainly by presentations and videos, questions and emerging issues by class discussions while relevant methodologies by laboratory experiments.

All presentations will be tailored to the students' previous knowledge and will include digital learning resources such as video, audio, animations and images concerning biological phenomena and procedures to make presentations more attractive and interesting, capturing the students' attention. Key topics will be extensively discussed in classroom in such a way that students can understand them in depth. Classroom work is expected to cover the exams.

Students will also select and prepare their own presentations concerning e.g. different genetic syndromes and hematological neoplasms. This way they have the opportunity to work individually, develop skills relevant to analysis and interpretation of sources and improve their public speaking. Moreover, in the classroom, interesting genetic topics will be analyzed and through this analysis students alone, in small groups or as a class will be able to improve scientific skills such as research analysis and interpretation of the results. As part of the course, debates between small groups with selected topics will be organized so that the students improve public speaking and research skills. Debates also will allow them to think about aspects and perspectives they may not have considered, and encourage them to speak strategically and learn how to create a persuasive argument.

Learning Objectives

Students will learn:

- The basic genetic terminology of human Genetics such as genome, DNA, chromosomes, genes and gene mutations.
- What makes us so similar and yet so unique and how our genetic profile can enable positive lifestyle adjustments so as to influence subjective well-being
- The applications of chromosome and gene analysis in:

-prenatal diagnosis, genetic syndromes and infertility

-early diagnosis, prognosis and treatment selection of patients with hematological neoplasms (e.g. personalized treatment)

- How genetic analysis is being used for a wide range of non-clinical purposes, such as crime investigation, determining paternity and identification of victims in decomposition, due to natural disasters or war.
- Research design in Genetics

By the end of the course, students will be able to:

- Understand the difference between genome, DNA, genes and chromosomes
- Realize the genetic causes of genetic syndromes, infertility, miscarriages and multifactorial diseases such as cancer and Alzheimer's disease, diseases that may experience in their life
- Understand the applications of genetic tests in daily life, especially in the current medical practice and research but also in the society
- Recognize the difference between chromosome and gene analysis, when we perform them and what we can identify from each test
- Understand how genetic variations influence brain function, social behavior, educational attainment and our health.
- Evaluate new developments in genetic research that are reported in news media

Course Requirements

The course structure consists of a combination of presentations, videos, discussions, group projects, debates, and laboratory experiments. The course requirements include:

- Arriving on time. If unable to attend class, you have to inform me beforehand by sending an email.
- Class presence and contribution are very important factors. They include physical and mental presence in the classroom and active participation in class discussions. Students are expected to ask and/or answer questions and express their opinions during class. If students are extremely uncomfortable speaking in front of an audience, they may send their opinions or afterthoughts via email.
- Reading the corresponding course material from the presentations which will be distributed to students in PowerPoint or PDF file formats and is sufficient for student exams.
- Group projects and presentations: Group projects based on a given subject will be conducted and presented by the students (lasted no longer than 10 minutes).

Artificial intelligence (AI)

The use of artificial intelligence (AI) tools (e.g., ChatGPT, automated presentation generators, or similar software) to create all or most of your presentation including slides and content is not allowed. AI is a means, not an end and can serve as a valuable tool to enhance learning when used responsibly. AI may not be used as a substitute for your own effort or understanding. Presentations must reflect your own work and thinking. Submitting AI-generated work as your own will be considered a violation of academic integrity and may result in penalties. If it is suspected that AI was improperly used by students to complete an assignment, they may be asked to explain or discuss their work orally to confirm that they have the knowledge their submitted work represents. Any unauthorized use of AI will be treated in accordance with the institution's academic integrity policy.

CYA Attendances and Absences policy

Students are expected to arrive on time. Absences are recorded at every class/lab. Class attendance takes precedence over other student appointments, travel, volunteering, or visiting friends/family, and missing class for these reasons is not excused. Three (3) unexcused absences in any class may lower the final course grade. Students must make up missed work for any absence (excused or unexcused) and communicate with instructors about requirements. Failure to complete missed work may result in the reduction of minimum one letter grade. Because participation is integral to learning at CYA, a high number of excused absences may still affect the course grade, per the course's participation policy.

Evaluation and Grading

Assignment	Weight
Multiple-choice final exams:	20%
Class presence and active contribution:	30%
Student active participation in lab experiments:	20%
Student presentations:	30%

Student presentations: students pick one subject related to the course that is of interest to them and prepare a presentation.

Multiple-choice final exams: based on the most important slides from the lessons that will be sent you by e-mail

Evaluation Criteria - Course Assignments

- Slides reading
- Student presentations
- Student active participation of lab experiments
- Reading of selected pages from Genetics and Genomics in Medicine. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024 or selected papers from the scientific literature

CYA Regulations and Accommodations Attendance Policy

CYA regards attendance in class and on-site (in Athens or during field study trips) as essential. Absences are recorded and have consequences. Illness or other such compelling reasons which result in absences should be reported immediately to the Student Affairs Office, via the form available in the Student Portal.

ePolicy on Original Work

Unless otherwise specified, all submitted work must be your own original work. Any ideas taken from the work of others must be clearly identified as quotations, paraphrases, summaries, figures etc., and accurate internal citations and/or captions (for visuals) as well as an accompanying bibliography must be provided.

Use of Laptops

In-class or onsite use of laptops and other devices is permitted if this facilitates course-related activities such as note-taking, looking up references, etc. Laptop or other device privileges will be suspended if devices are not used for class-related work.

Class Schedule

Class Day	Topic / Readings / Assignments Due
1	Welcoming New Students: Course overview and introduction
2	Presentation 1: Basic genetic terminology: Genome, DNA, chromosomes, genes <i>Required Reading</i> Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A Hamosh. 9th edition 2024. Pages: 5-7
3	Presentation 2: Human Chromosomes: structure, function and types of chromosome aberrations <i>Required Reading</i> Selected paragraphs from: Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A Hamosh. 9th edition 2024. Page: 68-75
4	Presentation 3: Chromosome analysis as an important diagnostic tool in prenatal diagnosis and genetic syndromes <i>Required Reading</i> Ekin Ozkan; Marcelo P. Lacerda. Genetics, Cytogenetic Testing and Conventional Karyotype. Copyright ©2024, StatPearls Publishing LLC.

5	<p>Presentation 4: How chromosome aberrations affect infertility and miscarriages</p> <p><i>Required Reading</i> Selected paragraphs from: Yahaya, T.O., Oladele, E.O., Anyebe, D. et al. Chromosomal abnormalities predisposing to infertility, testing, and management: a narrative review. Bull Natl Res Cent 45, 65 (2021). https://doi.org/10.1186/s42269-021-00523-z</p>
6	<p>Lab 1: Human cells culturing and monitoring, chromosome fixation and slides preparation for chromosome analysis (karyotype) in peripheral blood samples</p>
7	<p>Presentation 5: How chromosome abnormalities affect diagnosis, prognosis and treatment selection in hematological neoplasms</p> <p><i>Required Reading</i> Selected paragraphs from: Balciuniene J, Ning Y, Lazarus HM, Aikawa V, Sherpa S, Zhang Y, Morrissette JJD. Cancer cytogenetics in a genomics world: Wedding the old with the new. Blood Rev. 2024 Jul;66:101209. doi: 10.1016/j.blre.2024.101209. Epub 2024 May 7. PMID: 38852016.</p>
8	<p>Lab 2: Chromosome analysis and detection of chromosome abnormalities in genetic syndromes and hematological malignancies</p>
9	<p>Presentation 6: Fluorescence <i>in situ</i> hybridization (FISH), a molecular cytogenetic method used in prenatal/postnatal diagnosis and hematological neoplasm cases, especially for detection of submicroscopic aberrations</p> <p><i>Required Reading</i> Selected paragraphs from: Balciuniene J, Ning Y, Lazarus HM, Aikawa V, Sherpa S, Zhang Y, Morrissette JJD. Cancer cytogenetics in a genomics world: Wedding the old with the new. Blood Rev. 2024 Jul;66:101209. doi: 10.1016/j.blre.2024.101209. Epub 2024 May 7. PMID: 38852016.</p>
10	<p>Lab 3: FISH technique procedure for detection of submicroscopic aberrations in hematological malignancies</p>
11	<p>Lab 4: FISH analysis: detection of submicroscopic aberrations in hematological malignancies by fluorescence microscope and ISIS fluorescence imaging system</p>
12	<p>Project 1: Student presentations concerning genetic syndromes</p>
13	<p>Project 2: Student presentations concerning hematological neoplasms</p>
14	<p>Presentation 7: Gene mutations and polymorphisms detected by molecular analysis</p> <p><i>Required Reading</i> Selected paragraphs from: Berisha SZ, Shetty S, Prior TW, Mitchell AL. Cytogenetic and molecular diagnostic testing associated with prenatal and postnatal birth defects. Birth Defects Res. 2020 Mar 1;112(4):293-306. doi: 10.1002/bdr2.1648. PMID: 32115903; PMCID: PMC9290954</p>
15	<p>Presentation 8: Alzheimer's disease and genetic analysis</p> <p><i>Required Reading</i> Understanding Genetics and Alzheimer's Disease. Alzheimer Society of Canada https://alzheimer.ca/ab/sites/ab/files/documents/research_understanding-genetics-andalzhaimers-disease.pdf</p>
16	<p>Presentation 9: The role of Genetics in subjective well-being</p> <p><i>Required Reading</i> Røysamb, E., Nes, R.B. The role of genetics in subjective well-being. Nat Hum Behav 3, 3 (2019) https://doi.org/10.1038/s41562-018-0494-1</p>
17	<p>Presentation 10: Gene therapy, CRISPR gene editing technology, targeted therapies and immunotherapy</p> <p><i>Required Reading</i> Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024. Pages: 368-369</p>

18	Presentation 11: Consequences of environmental genotoxic exposure and DNA damage <i>Required Reading</i> Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A Hamosh. 9th edition 2024. Pages: 369-371
19	Presentation 12: The use of DNA in criminal investigations, determining paternity and identification of unrecognized victims in physical disasters or war <i>Required Reading</i> <i>Selected paragraphs from:</i> Muhammad Arjamand, Muhammad Shahid Cholistani, Sabahat Shakoor, and Muhammad Farhan, "Forensic DNA Profiling: Its Role and Advancements in Criminal Investigations," International Journal of Multidisciplinary Research and Publications (IJMRAP), Volume 7, Issue 5, pp. 42-46, 2024.
20	Lab 5: DNA isolation from peripheral blood/bone marrow samples
21	Lab 6: PCR (Polymerase Chain Reaction) and DNA electrophoresis
22	Presentation 13: Genetic Counseling and Ethical Considerations in genetic analysis <i>Required Reading</i> Selected paragraphs from: Principles of biomedical ethics. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024. Pages: 425-429
23	Project 3: Student presentations and debates concerning prenatal diagnosis and paternity determination
24	Revision session

N.B.: The course schedule, in terms of subjects and readings, may be subject to change to benefit student learning and to keep up to date with current research.

COURSE BIBLIOGRAPHY

Lecture materials (PowerPoint slides) and selected paragraphs from:

- Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024. Pages: 5-7
- Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024. Page: 68-75
- Ekin Ozkan; Marcelo P. Lacerda. Genetics, Cytogenetic Testing and Conventional Karyotype. Copyright ©2024, StatPearls Publishing LLC.
- Yahaya, T.O., Oladele, E.O., Anyebe, D. et al. Chromosomal abnormalities predisposing to infertility, testing, and management: a narrative review. Bull Natl Res Cent 45, 65 (2021). <https://doi.org/10.1186/s42269-021-00523-z>
- Balciuniene J, Ning Y, Lazarus HM, Aikawa V, Sherpa S, Zhang Y, Morrissette JJD. Cancer cytogenetics in a genomics world: Wedding the old with the new. Blood Rev. 2024 Jul;66:101209. doi: 10.1016/j.blre.2024.101209. Epub 2024 May 7. PMID: 38852016.
- Berisha SZ, Shetty S, Prior TW, Mitchell AL. Cytogenetic and molecular diagnostic testing associated with prenatal and postnatal birth defects. Birth Defects Res. 2020 Mar 1;112(4):293-306. doi: 10.1002/bdr2.1648. PMID: 32115903; PMCID: PMC9290954.
- Understanding Genetics and Alzheimer's Disease. Alzheimer Society of Canada https://alzheimer.ca/ab/sites/ab/files/documents/research_understanding-genetics-and-alzheimers-disease.pdf
- Røysamb, E., Nes, R.B. The role of genetics in subjective well-being. Nat Hum Behav 3, 3 (2019). <https://doi.org/10.1038/s41562-018-0494-1>.
- Genetics and Genomics in Medicine. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024. Pages: 368-369
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- Muhammad Arjamand, Muhammad Shahid Cholistani, Sabahat Shakoor, and Muhammad Farhan, "Forensic DNA Profiling: Its Role and Advancements in Criminal Investigations," International Journal of Multidisciplinary Research and Publications (IJMRAP), Volume 7, Issue 5, pp. 42-46, 2024.
- Principles of biomedical ethics. Thomson & Thompson. Thomson & Thompson.R. Cohn, S.Scherer, A. Hamosh. 9th edition 2024. Pages: 425-429