Course Title: Aging: Science and Technology for Longevity
Course Code: WELL 03
Instructor: Ronjon Nag, PhD; Sohila Zadran, PhD

Course Summary:

Why do we get old? Do we have to age? Or is aging just another disease that can be ultimately cured? In this course, we will take a closer look at the aging processes from molecules to humans. This course presents an in-depth analysis of the biology of aging, building up from changes occurring at the molecular and cellular level and analyzing the consequences at the systems level. We will also explore how age-related diseases manifest itself and their current clinical prognosis.

We will then transition the course from the biology of aging to the biology of extending human lifespan and how it has already manifested itself in certain human populations (centenarians). We will look at technologies such as artificial intelligence to assist us in creating robotic and software assistants as we get older. Lastly we will take a deeper dive into the concept of immortality and the singularity and how research today is taking us one step closer to living forever.

The goal of this course is to provide a fundamental understanding of human aging, its clinical relevance and current innovations to both understand the aging process and to treat aging. The course is at an introductory level and no pre-requisites are required.

Grade Options and Requirements:

- No Grade Requested (NGR) : This is the default option. No work will be required; no credit shall be received; no proof of attendance can be provided.

- Credit/No Credit (CR/NC): A passing grade (for "Credit") = 60% attendance (3 classes attended) ; quizzes must be answered (any score accepted); discussion comments to be made online every week on provided topic.

- Letter Grade (A, B, C, D, No Pass): Students must attend at least 60% of class sessions, provide discussion topic comments and complete a minimum three-page research report (maximum 10 pages)

Tentative Weekly Outline:

Week 1: Course Overview; Hallmarks, Psychology and Economics of Aging – Ronjon Nag

This lecture will be an overview of the course covering the science and technology in the field and provide the background of macro trends of increasing longevity of the human population. How has longevity increased over the last 200 years and what are the factors that have caused such changes. What are the stresses of an increasingly aged population – psychological, economic and environmental. How has the perception of age changed over the years. Will also cover the basics of biology, genomics, and hallmarks of aging.

Required reading:

• Lockenhoff et al. Perceptions of Aging across 26 Cultures and their Culture-Level Associates *Psychology and Aging, 24*(4), 941–954.

• https://medicalxpress.com/news/2018-11-psychology-successful-aging.html

• Menkin et al, "Positive Expectations Regarding Aging Linked to More New Friends in Later Life", *J* Gerontol B Psychol Sci Soc Sci, 2017, Vol. 72, No. 5, 771–781

Week 2: Molecular Biology of Aging: From DNA to Cells - Sohila Zadran

This lecture will be an introduction to the molecular biology of aging in cells and how they are regulated. We will also discuss theories of biological and cellular aging. Expect a brief overview of Oxidative Stress, Inflammation, Mitochondrial Functions and Telomere/Telomerase biology and stochastic effects in cellular aging

Required reading:

• Johnson, F. Brad, David A. Sinclair, and Leonard Guarente. "Molecular biology of aging." Cell 96.2 (1999): 291-302.

• Rajput, Mohit, et al. "The Biology of Aging and Cancer: A Complex Association." Models, Molecules and Mechanisms in Biogerontology. Springer, Singapore, 2020. 465-497.

• Cohen, Alan A., Véronique Legault, and Tamàs Fülöp. "What if there's no such thing as "aging"?." Mechanisms of Ageing and Development (2020): 111344.

Week 3: Systems Biology of Aging In Humans: From Pathologies to Centenarians - Sohila Zadran

This lecture will explore how human pathologies from cancer to osteoporosis develop as humans age. Students will also learn about case studies of accelerated aging (Progeria) and also receive an overview of how populations of centenarians combat aging. We will focus on both degenerative diseases and inflammatory diseases commonly associated with human aging, its current clinical understanding and prognosis

Required Reading:

• Liguori, Ilaria, et al. "Oxidative stress, aging, and diseases." Clinical interventions in aging 13 (2018): 757.,

• Wick, G., Jansen-Dürr, P., Berger, P., Blasko, I., & Grubeck-Loebenstein, B. (2000). Diseases of aging. Vaccine, 18(16), 1567-1583.

• Frasca, Daniela, Bonnie B. Blomberg, and Roberto Paganelli. "Aging, obesity, and inflammatory age-related diseases." Frontiers in Immunology 8 (2017): 1745.

Week 4: Current Biological Models and Theories to Extending Human Lifespan – GUEST LECTURER TBD

This lecture will explore the current experimental models used - from yeast to primates - in research to monitor and test how to extend lifespan. We will also examine on current research on human life extension including calorie restriction, fasting, metformin, sirtuins and rapamycin.

Required Reading:

• Agarwal, Beamon, and Joseph A. Baur. "Resveratrol and life extension." Annals of the New York Academy of Sciences 1215.1 (2011): 138-143.

• Flanagan, Emily W., et al. "Calorie Restriction and Aging in Humans." Annual Review of Nutrition 40 (2020): 105-133.

• Zhao, Lijun, et al. "Sirtuins and their Biological Relevance in Aging and Age-Related Diseases." Aging and disease (2020): 0.

Reading: Innovations and Pitfalls on the road to life extension

Week 5: Evaluating Longevity Claims – Ronjon Nag, PhD; Aging in women– Sohila Zadran

This lecture will discuss how we can evaluate longevity claims and try and separate snake oil from real improvement. Additionally, we will discuss specifically the aging differences in women and men.

Week 6: Boundaries of Humanity in the age of artificial intelligence and biotechnology –

This lecture will explore the limits of human longevity and how longevity changes between animals and humans. As we replace parts of humans with AI based prostheses, is there ever a point when humans stop being humans. Is there a point when machines become human ? What is it to be human? What are the ethical considerations of living longer if we technologies allow us to live longer.

Required Reading:

• Buntz, B. (2016, January 26). The Future of Medical Technology according to Ray Kurzweil | Qmed. Retrieved from: (link)
  o Click through to the different pages to read in its entirety
• Woollaston for, V. (2014, September 23). 'Digital twins' will make decisions for us - and even console loved ones after we die by 2020, futurist claims. *Daily Mail.* Retrieved from: (link)
• Metzl, J. (2016, May 2). Homo Sapiens 2.0? We need a species-wide conversation about the future of human genetic enhancement. Retrieved from: (link)

What you can expect from us

We are dedicated to providing the best possible learning experience for you. We will come on-time and prepared to each class session, ready to lead discussions and answer your questions about the papers and other content. We will promote an inclusive learning environment by valuing contributions from students of all backgrounds and incorporating a variety of activities in our class sessions. We designed our course structure and assignments to address our course goals as much as possible, and we are open to your feedback, which we will actively incorporate in making changes throughout this year's course and in future iterations of the course.

What you can expect of you

Primary literature discussions are a major component of this course. You are expected to have read the papers before class, complete the homework assignment, and come to class on-time and ready to discuss with your classmates. The amount of time spent reading the paper each week will vary based on your expertise and comfort with reading primary literature, but we expect you to spend **~1 hour each week** on reading and preparing for discussion.

During class, we expect that you will be respectful of other students while acknowledging the diversity of backgrounds and expertise in the room. We expect that you are in the classroom to learn and engage with the material and your peers. Taking notes on electronic devices is encouraged, but please refrain from texting or using social media during class time.

Online Learning

All class meetings will be recorded via Zoom, and are available for students to view on Canvas. Ideally the educational experience is enhanced if you attend since you can ask questions, but it's ok to just watch the recordings.

Online Learning Expectations

- Please be on time!
- Mute your microphone if you aren't talking.
- Turn on video if available to you. (encouraged, not required)
- Use a virtual background.
- Display your real name (+ pronouns).
- Feel free to use the chat function! We ask that you keep messages appropriate and relevant to the lessons.

We are open to feedback on what policies would make you feel more comfortable in our classroom! Please feel free to contact us at any time.

Homework Assignments

In addition to reading each week's assigned paper, you are expected to participate in online discussions either about the paper or a provided discussion prompt.

Your responses should be uploaded to the appropriate Canvas Discussion topic (see the "Discussions" tab on Canvas) by **11:59pm on Wednesdays**. We encourage you to ask questions and discuss with each other in preparation for our class discussions!

We will do our best to accommodate you within reason, especially given the uncertain COVID-19 situation.