**Modeling the Pandemic: When Science Meets Politics**

**Professor: Philippe Lemoine**

**Academic Year 2021-2022: Spring semester**

**COURSE DESCRIPTION**

The COVID-19 pandemic has already caused millions of deaths and completely

upended the lives of billions as governments around the world imposed stringent

restrictions to contain the spread of the virus. Throughout the pandemic,

epidemiological models have been an essential tool to understand the pandemic and

guide policy, but few people really understand them. In this seminar, you will learn

how those models work and what they are used for. In particular, we’ll examine what

assumptions those models make and how they affect the results, so you can

understand in non-mathematical terms what’s behind the mathematics used in

epidemiological modeling. Armed with this knowledge, we’ll discuss how modeling can

be used to inform policy, as well as the limits of this practice. We’ll discuss the

scientific basis or lack thereof of the non-pharmaceutical interventions that were

implemented during the pandemic and examine the ethical dimensions of those

decisions.

**Sessions**

**1. Virology for dummies: What you need to know about viruses to model epidemics**

Kurzgesagt – In a Nutshell, "How the Immune System ACTUALLY Works" (YouTube video, mandatory)

Chris R. Triggle et al., "A Comprehensive Review of Viral Characteristics, Transmission, Pathophysiology, Immune Response, and Management of SARS-CoV-2 and COVID-19 as a Basis for Controlling the Pandemic", *Frontiers in Immunology*, 2021 (optional)

Andrew T. Levin et al., "Assessing the age specificity of infection fatality rates for COVID-19: systematic review, meta-analysis, and public policy implications", *European Journal of Epidemiology*, 2020 (optional)

**2. R and all that : Some basic concepts of the epidemiology of infectious diseases**

The Royal Society, "Reproduction number (R) and growth rate (r) of the COVID-19 epidemic in the UK: methods of estimation, data sources, causes of heterogeneity, and use as a guide in policy formulation", 2020 (mandatory)

Sonja Lehtinen et al., "On the relationship between serial interval, infectiousness profile and generation time", *Journal of the Royal Society Interface*, 2021 (optional)

Karla Therese L. Sy, et al., "Population density and basic reproductive number of COVID-19 across United States counties", *PLoS One*, 2021

Jacco Wallinga and Marc Lipsitch, "How generation intervals shape the relationship between growth rates and reproduction numbers", *Proceedings of The Royal Society — Biological Sciences*, 2006 (optional)

**3. Introduction to scientific modeling**

Eric Winsberg, *Philosophy and Climate Science*, Cambridge University Press, 2018 (chapters 1 & 2, mandatory)

Jordana Cepelewicz, "The Hard Lessons of Modeling the Coronavirus Pandemic", *Quanta Magazine*, 2021 (optional)

Fred Brauer, "Mathematical epidemiology is not an oxymoron", *BMC Public Health*, 2009 (optional)

**4. The SIR model and its variants – Part 1**

Alexander Bird, "A simple introduction to epidemiological modeling", 2020 (mandatory)

Nicholas C. Grassly and Christope Fraser, "Mathematical models of infectious disease transmission", *Nature Reviews Microbiology*, 2008 (optional)

Derrick Louz et al., "Emergence of viral diseases: mathematical modeling as a tool for infection control, policy and decision making", *Critical Reviews in Microbiology*, 2010 (optional)

**5. The SIR model and its variants – Part 2**

Julie C. Blackwood & Lauren M. Childs, "An introduction to compartmental modeling for the budding infectious disease modeler", *Letters in Biomathematics*, 2018 (mandatory, except section 3, which is optional)

John Cochrane, "A SIR model with behavior", *The Grumpty Economist*,2020 (optional)

**6. The SIR model and its variants – Part 3**

Philippe Lemoine, "Have we been thinking about the pandemic wrong? The effect of population structure on transmission", *CSPI*,2021 (mandatory, but the last section is optional)

M. Gabriela M. Gomes et al., "Individual variation in susceptibility or exposure to SARS-CoV-2 lowers the herd immunity threshold", 2021 (optional)

Ronan F. Arthur et al., "Adaptive social contact rates induce complex dynamics during epidemics", *PLOS Computational Biology*,2021 (optional)

**7. Estimating the effects of non-pharmaceutical interventions – Part 1**

*Midterm exam*

Seth Flaxman et al., "Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe", *Nature,* 2020 (mandatory)

Solomon Hsiang et al., "The effect of large-scale anti-contagion policies on the COVID-19 pandemic", *Nature,* 2020 (optional)

**8. Estimating the effects of non-pharmaceutical interventions – Part 2**

Philippe Lemoine, "Lockdown, science and voodoo magic", *Nec Pluribus Impar*, 2020 (mandatory)

Vincent Chin et al., "Effect estimates of COVID-19 non-pharmaceutical interventions are non-robust and highly model-dependent", *Journal of Clinical Epidemiology*, 2021 (optional)

Christopher R. Berry et al., "Evaluating the effects of shelter-in-place policies during the COVID-19 pandemic", *PNAS,* 2021 (optional)

**9. Utilitarianism and its discontents**

James Rachels, *The Elements of Moral Philosophy*, McGraw-Hill Education, 2002 (chapter 7 & 8, mandatory)

Antoinette Baujard, "Utilitarianism and anti-utilitarianism", 2013 (optional)

**10. The ethics of restrictions against covid – Part 1**

Anna Scherbina, "Could the United States benefit from a lockdown? A cost-benefit analysis", *Centre for Economic Policy Research*, 2021 (mandatory)

Ryan Bourne, "A Cost‐​Benefit Analysis of a Lockdown Is Very Difficult To Do Well", *CATO*,2021 (optional)

Peter Godfrey-Smith, "Covid heterodoxy in three layers", *Monash Bioethics Review*, 2021 (optional)

**11. The ethics of restrictions against covid – Part 2**

Bryan Caplan, "Life-Years Lost: The Quantity and The Quality", *EconLog*,2020 (mandatory)

Douglas W. Allen, "Covid-19 Lockdown Cost/Benefits: A Critical Assessment of the Literature", *International Journal of the Economics of Business*, 2021 (optional)

James D. Long, "Why Nobody Will Ever Agree on Whether COVID Lockdowns Were Worthwhile", *The Conversation*,2021 (optional)

**12. The transition toward endemicity or how pandemics end**

Philippe Lemoine, "Why COVID-19 is here to stay, and why you shouldn’t worry about it", *CSPI*, 2021 (mandatory)

# Jennie S. Lavine, Ottar N. Bjorstad and Rustom Antia, "Immunological characteristics govern the transition of COVID-19 to endemicity", *Science*, 2021 (optional)

**Course validation**

1. Participation grade (10%) : This will reward your participation in class, such as the questions you ask and how you take part to discussions. Any questions that you send by email will also count toward this grade if it’s relevant to topics discussed in class.

2. Midterm written test in class (45%) : You will have one hour to answer 3 to 4 questions on the material covered previously in class. Each answer should be clear, short and demonstrate that you understand a concept presented in class.

3. Final take-home paper (45%) : You will have to write a short paper on 1 of 2 topics related to material discussed in the course. This essay must demonstrate that you understand the material and that you can articulate a position on a question related to pandemic mitigation.

**BIBLIOGRAPHY**

Kurzgesagt – In a Nutshell, "How the Immune System ACTUALLY Works" (YouTube video)

Chris R. Triggle et al., "A Comprehensive Review of Viral Characteristics, Transmission, Pathophysiology, Immune Response, and Management of SARS-CoV-2 and COVID-19 as a Basis for Controlling the Pandemic", *Frontiers in Immunology*, 2021

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The Royal Society, "Reproduction number (R) and growth rate (r) of the COVID-19 epidemic in the UK: methods of estimation, data sources, causes of heterogeneity, and use as a guide in policy formulation", 2020

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M. Gabriela M. Gomes et al., "Individual variation in susceptibility or exposure to SARS-CoV-2 lowers the herd immunity threshold", 2021

Ronan F. Arthur et al., "Adaptive social contact rates induce complex dynamics during epidemics", *PLOS Computational Biology*,2021

Janyce Eunice Gnanvi et al., "On the reliability of predictions on Covid-19 dynamics: A systematic and critical review of modelling techniques", *Infectious Disease Modeling*, 2020

John P. A. Ioannidis et al., "Forecasting for COVID-19 has failed", *International Journal of* Forecasting, 2020

Seth Flaxman et al., "Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe", *Nature,* 2020

Solomon Hsiang et al., "The effect of large-scale anti-contagion policies on the COVID-19 pandemic", *Nature,* 2020

Philippe Lemoine, "Lockdown, science and voodoo magic", *Nec Pluribus Impar*, 2020

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# Jennie S. Lavine, Ottar N. Bjorstad and Rustom Antia, "Immunological characteristics govern the transition of COVID-19 to endemicity", *Science*, 2021

**To go further**

Maia Martcheva, *An Introduction to Mathematical Epidemiology*, Springer, 2015

Herbert W. Hethcote, "The Mathematics of Infectious Diseases", *SIAM Review*,2000

Istvan Z. Kiss, Joel C. Miller, Peter L. Simon, *Mathematics of Epidemics on Networks: From Exact to Approximate Models*, Springer, 2017

Amartya Sen and Bernard Williams (eds.), *Utilitarianism and Beyond*, Cambridge University Press, 1982

Ginés de Rus, *Introduction to Cost-Benefit Analysis: Looking for Reasonable Shortcuts*, Edward Edgar Publishing, 2021