Introduction to Bioengineering
BIOE/ENGR.80
Stanford University

Spring 2020 Class Slides

Day 1
6 April 2020

Week 1

CONCEPT
SKILL

Why engineer biology?

- 40 years of biotechnology
- biology as nature's planetary-scale technology
- biology++ (e.g., electrofermentation)

What makes living matter unique?

- unique physics (e.g., continuous detail scaling)
- unique challenges & opportunities (e.g., grow anywhere)
- unique time (e.g., COVID, pace-of-change)

How to read a research paper

- triage at every step
- hunt for #1 declarative claim in Abstract
- hunt for primary evidence in Figures

Week 2

CONCEPT
SKILL

Bioengineering for people health

Bioengineering for planet health

Bioengineering for political health

How to frame puzzles & discover connections

- Frame Storm
- Future Wheel

LIVE Le confinement prolongé jusqu'au 11 mai, annonce Emmanuel Macron

A partir de cette date, les écoles, les collèges et les lycées rouvriront « progressivement », a fait savoir le président de la République dans son discours. En revanche les restaurants, bars et cinémas resteront fermés.

Le coronavirus dans le monde : plus de 20 000 morts en Italie, accélération des contaminations en Russie

Le coronavirus en France : près de 15 000 personnes sont mortes

L'Espagne sort de son « hibernation » et distribue des masques dans le métro

ENQUÊTE

Nathaniel Herzberg

Les secrets de la chauve-souris, « souche à virus » au système immunitaire d'exception

Comme à chaque nouvelle poussée virale, le chiroptère revient sur le devant de la scène. Merveille de résilience vis-à-vis des maladies infectieuses, l'animal est l'objet de nombreuses études qui cherchent à percer le secret de son système immunitaire inné.

10 min de lecture

Coronavirus
Toutes les informations sur la pandémie et ses conséquences

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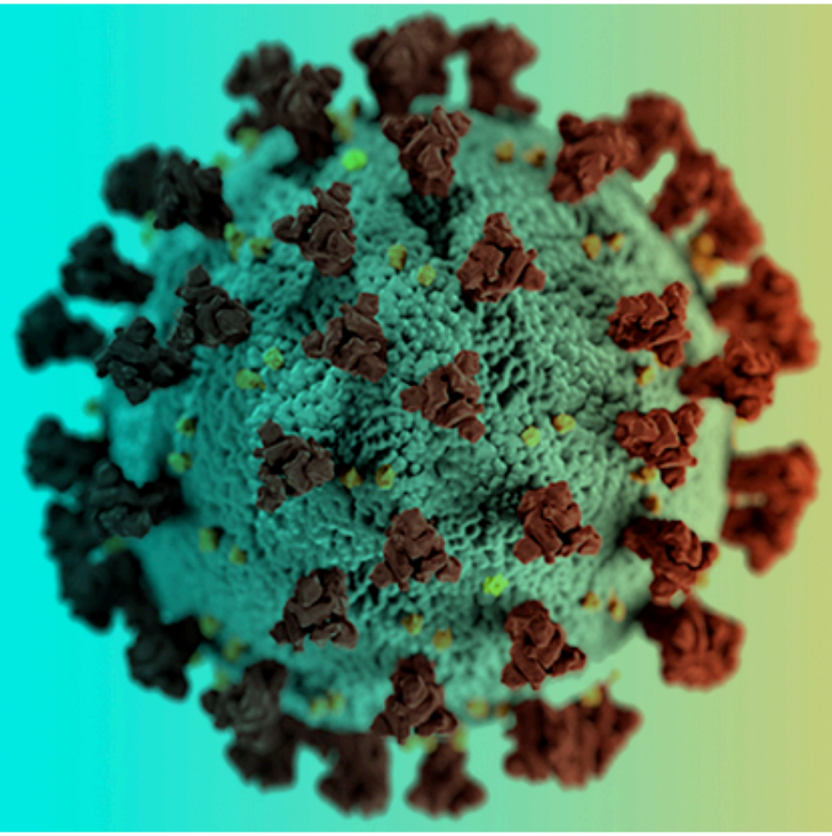
Latest information about COVID-19 »



Bioengineering research labs are currently engaged in COVID-19 related work

Breaking COVID Research

In response to the COVID-19 pandemic, Stanford Bioengineering labs are working on ways to prevent, diagnose, and treat the virus. By sharing ideas and collaborating, we can make greater progress together.

Learn more

What do all these examples of bioengineers working to help people's health have in common?

HINT — what sorts of things are or seem missing?

“The Cuyahoga River Caught Fire at Least a Dozen Times, but No One Cared Until 1969”

https://www.smithsonianmag.com/history/cuyahoga-river-caught-fire-least-dozen-times-no-one-cared-until-1969-180972444/

produce an idea or way of solving a problem
by holding a spontaneous group discussion

BRAINSTORM

FRAMESTORM

“the question you ask frames the answers you get” — Tina Seelig

Brainstorm your question (or at least question your question) before you go for solutions & answers

FOR EXAMPLE
“Let’s plan a birthday party for Mary” versus “Let’s plan something that Mary would enjoy”

Engineering approaches to pollution…

1. Ignore (e.g., dilution solves pollution)

2a. React (e.g., put out the fire)
2b. React better, in situ (e.g., buy a fire truck)
2c. React better, ex situ (e.g., capture fuel & treat)

3a. Prevent, change environment (e.g., spare-the-air)
3b. Prevent, change system inputs (e.g., unleaded gas)
3c. Prevent, change system (e.g., fridges w/o CFCs)

Engineering approaches to COVID19…

1. Ignore (e.g., _____)

2a. React (e.g., _____)
2b. React better, in situ (e.g., _____)
2c. React better, ex situ (e.g., _____)

3a. Prevent, change environment (e.g., _____)
3b. Prevent, change system inputs (e.g., _____)
3c. Prevent, change system (e.g., _____)

BREAKOUT #1

FRAMESTORM

Can you fill in all the blanks?

Can you change the question re: COVID?

Engineering approaches to COVID19…

1. Ignore (e.g., pandemic runs its course)

2a. React (e.g., urgent care, ICUs, ventilators)
2b. React better, in situ (e.g., diagnostics)
2c. React better, ex situ (e.g., better PPE, meds)

3a. Prevent, change environment (e.g., distancing)
3b. Prevent, change system inputs (e.g., vaccine)
3c. Prevent, change system (e.g., germ-line engr.?)

*What would we need to do to make
all infectious diseases obsolete by 2030?

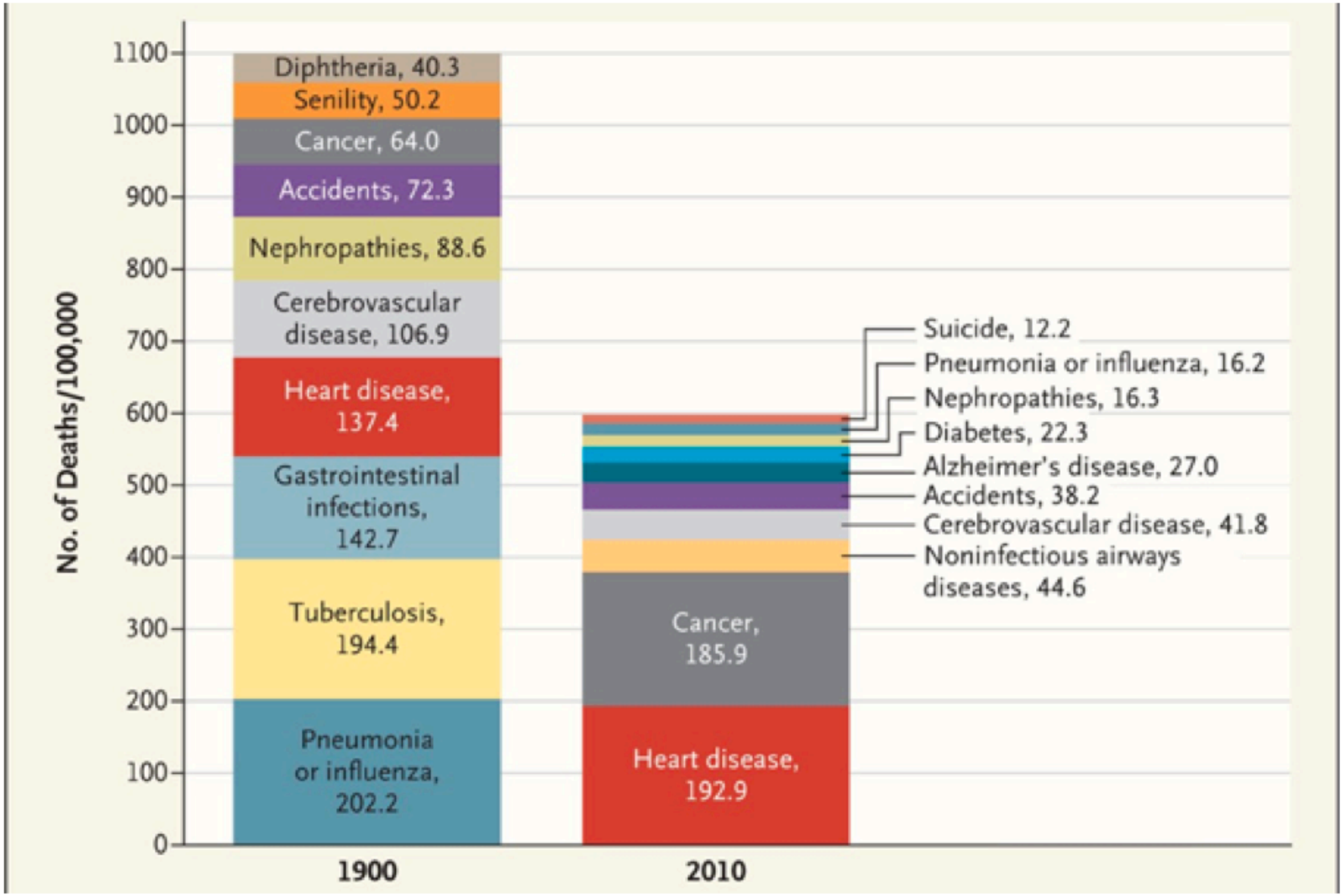
Causes of Death, Boston 1812

The DEATHS preceding were caused by Diseases and Casualties as follows, viz.

Abscesses	1	Hernia, or Rupture	3
Aneurism	1	Jaundice	10
Apoplexy	13	Inflammation of the bowels	1
Burns or Scalds	6	——— of the stomach	1
Cancer	5	Killed by lightning	1
Casualties	15	Insanity	1
Childbed	14	Intemperance	2
Cholera Morbus	6	Locked jaw	2
Colic	2	Mortification	11
Consumption	221	Old Age	26
Convulsions	36	Palsy	12
Cramp in the stomach	2	Pleurisy	8
Croup	1	Quinsy	15
Debility	28	Rheumatism	1
Decay	20	Rupture of blood vessels	1
Diarrhœa	15	Small-Pox,(at Rainsford's Island)	2
Drinking cold water	2	Sore throat	1
Dropsy	21	Spasms	2
——— in the head	23	Stillborn	49
Drowned	13	Suicide	1
Dysentery	14	Sudden death	25
Dispepsia or Indigestion	15	Syphilis	12
Fever, bilious	7	Teething	15
——— pulmonic	46	Worms	11
——— inflammatory	24	Whooping Cough	14
——— putrid	6	White swelling	2
——— typhus	33	Diseases not mentioned	48
Flux infantile	57		
Gout	3	Total,	942
Hoemorrhage	4		

https://www.nejm.org/doi/full/10.1056/NEJMp1113569

Changes in Causes, 1900 to 2010



Jones DS et al. N Engl J Med 2012;366:2333-2338 (source)

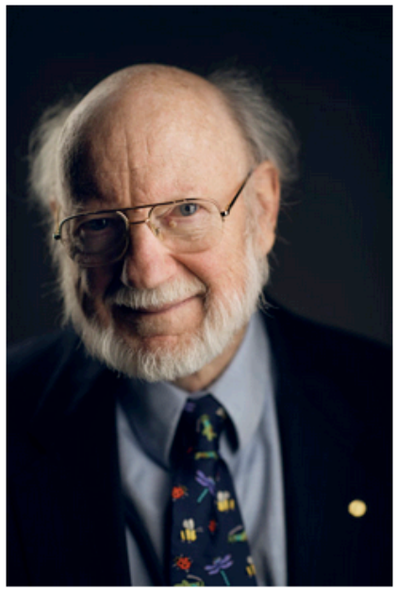
BREAKOUT #2

FRAMESTORM

Re: people health, what should bioengineers focus on?

Drawing from today's reading and what you know, what's missing from the data?

The Nobel Prize in Physiology or Medicine 2015



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William C. Campbell

Prize share: 1/4

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Satoshi Ōmura

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Tu Youyou

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Synthetic anti-malarial compound is bad news for artemisia farmers

Artemisinin breakthrough by synthetic biologists threatens to open new front in battle between microbes and people