Johns Hopkins Engineering

Immunoengineering

Immunoengineering Pathogens

Introduction

JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Immunoengineering

- Better understand Immunology
  - New tools
  - Data analysis
- Control immunological function
  - Inhibit unwanted responses
  - Activate dampened responses
  - Specify existing responses
- Combat pathogenic infections
  - Enhance existing therapies

Learning Objectives

- Describe economic burden of infectious disease and evaluate recent start ups
- Explain importance of diagnostic development for infectious diseases
- Define design criteria and evaluate efficacy of diagnostic tests
- Compare and contrast approaches to discover new therapeutic targets
- Describe several examples of biologics and biomaterials being developed as therapeutics for infectious diseases
- Utilize biologic and biomaterial design principles to develop solutions to pathogenic disease

Top Leading Causes of Death in the U.S.

1900

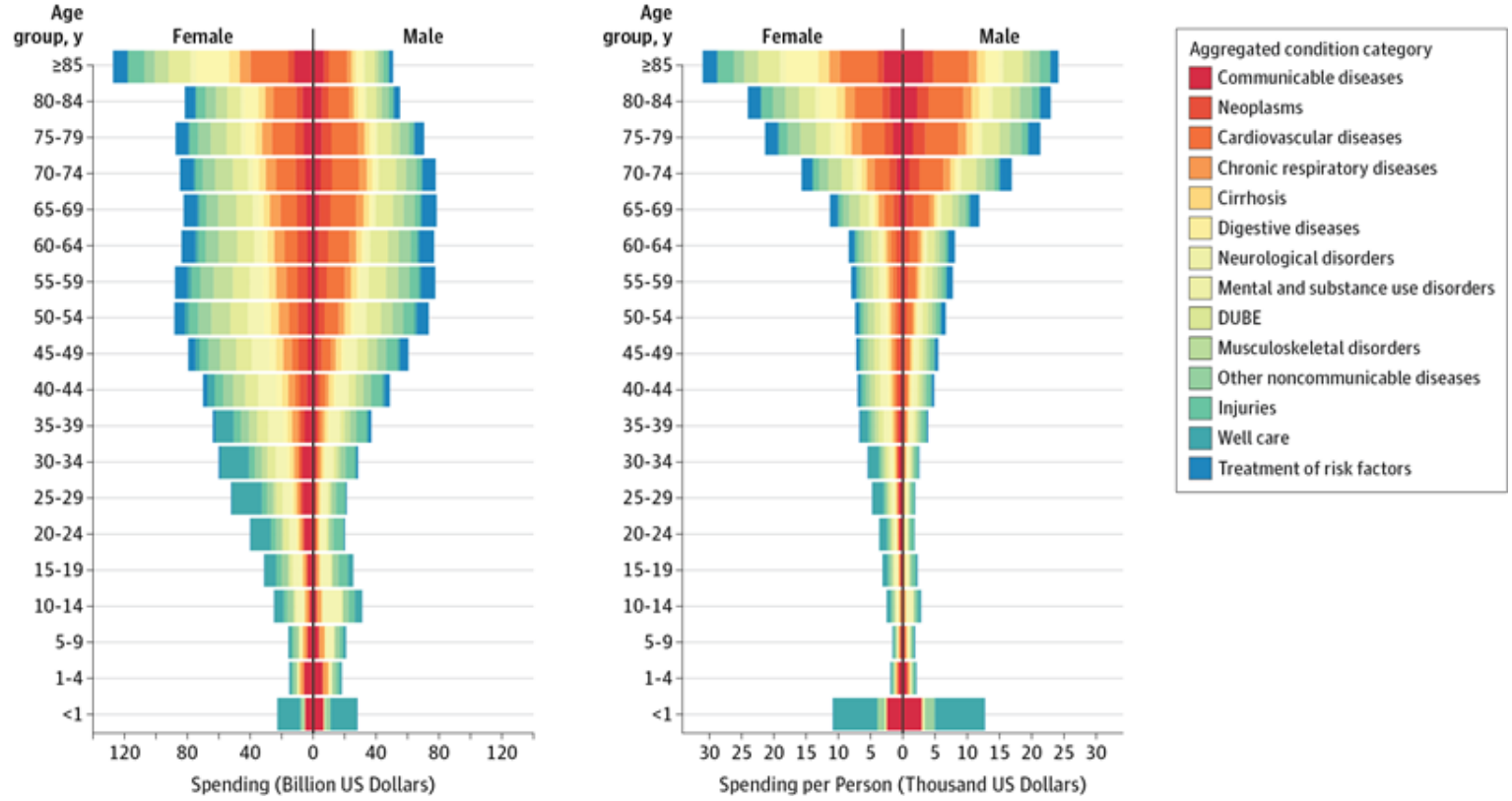
- Pneumonia
- Tuberculosis
- Diarrhea and enteritis
- Heart Disease
- Stroke
- Liver Disease
- Accidents
- Cancer

2016

- Heart Disease
- Cancer
- Respiratory Disease
- Accidents
- Stroke
- Alzheimer's Disease
- Diabetes
- Influenza/Pneumonia

https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm, https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4829a1.htm

US Health Expenditures



Dieleman, Joseph L., et al. "US spending on personal health care and public health, 1996-2013." *Jama* 316.24 (2016): 2627-2646.

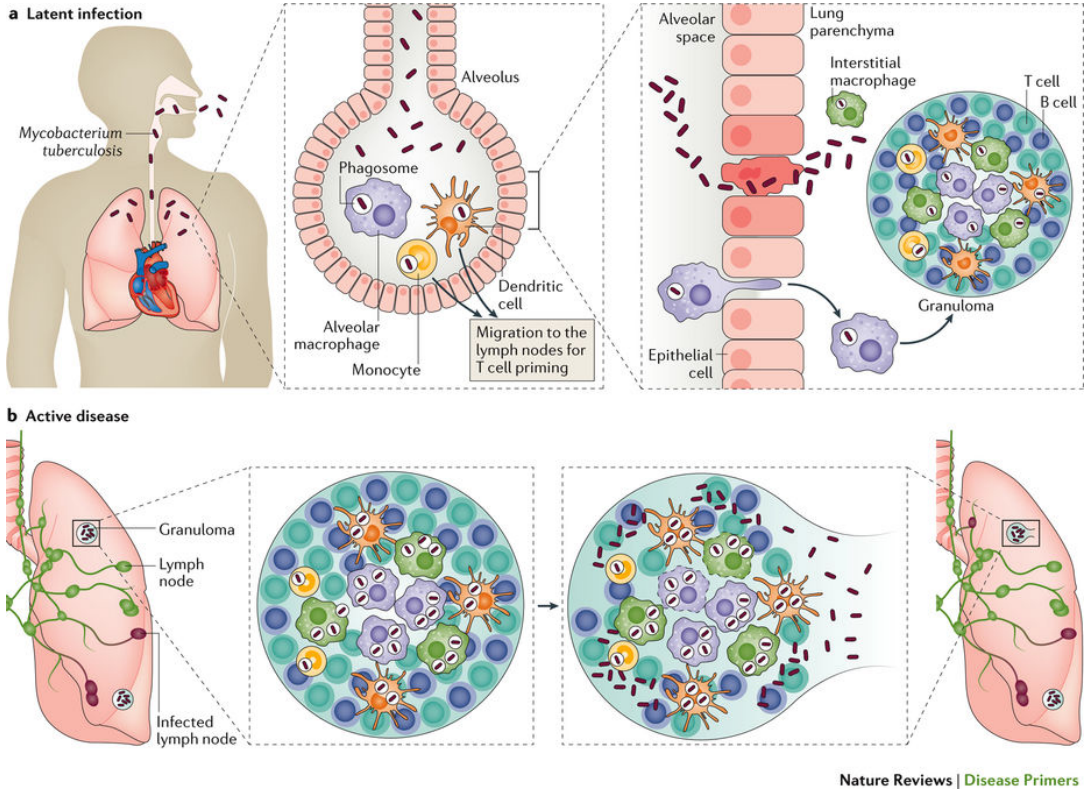
20 Largest Public Health Spending Conditions in U.S. in 2013

Rank[b]	Condition	2013 Spending (Billions of US Dollars), $	Annualized Rate of Change (1996 to 2013), %
	All causes	76.63	2.69
1	HIV/AIDS	3.52	4.97
2	Lower respiratory tract infections	1.78	15.68
3	Diarrheal diseases	0.93	14.11
4	Other infectious diseases (viral and chlamydial infection and streptococcal infection)	0.67	1.25
5	Hepatitis	0.60	6.77
6	Preterm birth complications (respiratory distress and extreme immaturity)	0.39	−0.67
7	Varicella	0.35	14.98
8	Tobacco (tobacco use disorder and cessation)	0.34	9.58
9	Family planning	0.29	9.38
10	Tetanus	0.19	1.66
11	Whooping cough	0.19	1.66
12	Diphtheria	0.19	1.66
13	Sexually transmitted diseases excluding HIV	0.18	3.80
14	Breast cancer	0.18	30.01
15	Meningitis	0.17	6.00
16	Low back and neck pain	0.14	8.96
17	Tuberculosis	0.14	0.92
18	Self-harm	0.14	14.51
19	Other neonatal disorders (feeding problems and temperature regulation)	0.13	1.00
20	Trachea, bronchus, and lung cancers	0.13	7.39
	Top 20 causes	10.64	5.59

Dieleman, Joseph L., et al. "US spending on personal health care and public health, 1996-2013." *Jama* 316.24 (2016): 2627-2646.

Example: Tuberculosis

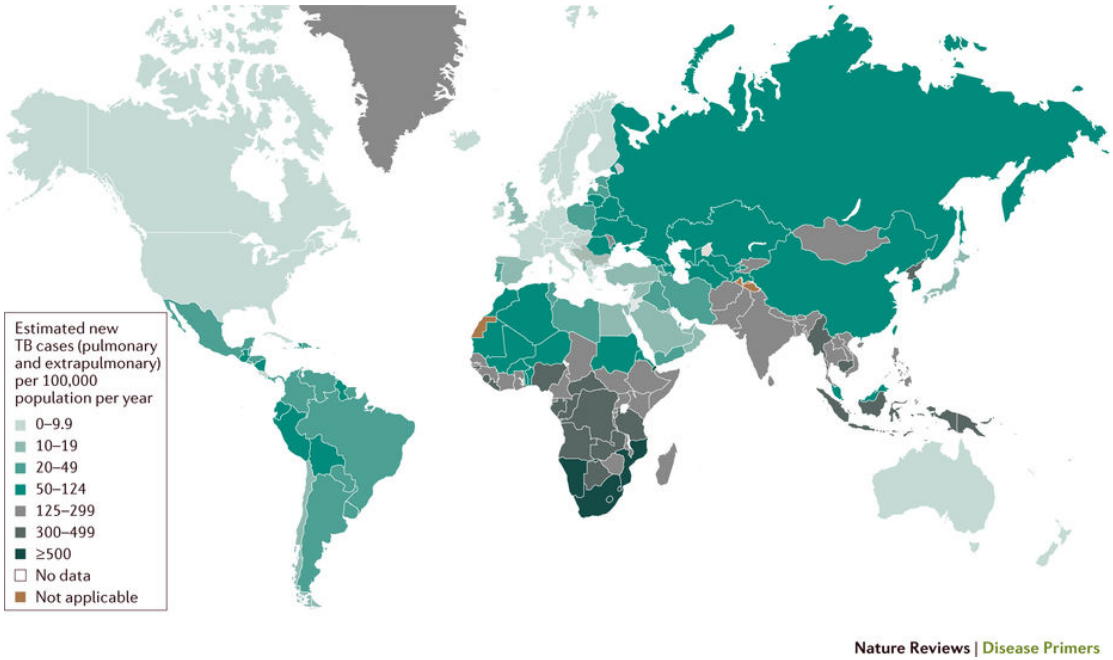
- Fever
- Fatigue
- Lack of appetite and weight loss
- Persistent cough and hemoptysis (coughing up blood)



Pai et al., Nature Reviews Disease Primers volume 2, 6076 (2016), doi:10.1038/nrdp.2016.76.

Example: Tuberculosis

- $6.9 billion spent for prevention and care in U.S. in 2017
- Less than 10 cases per 100,000 people per year



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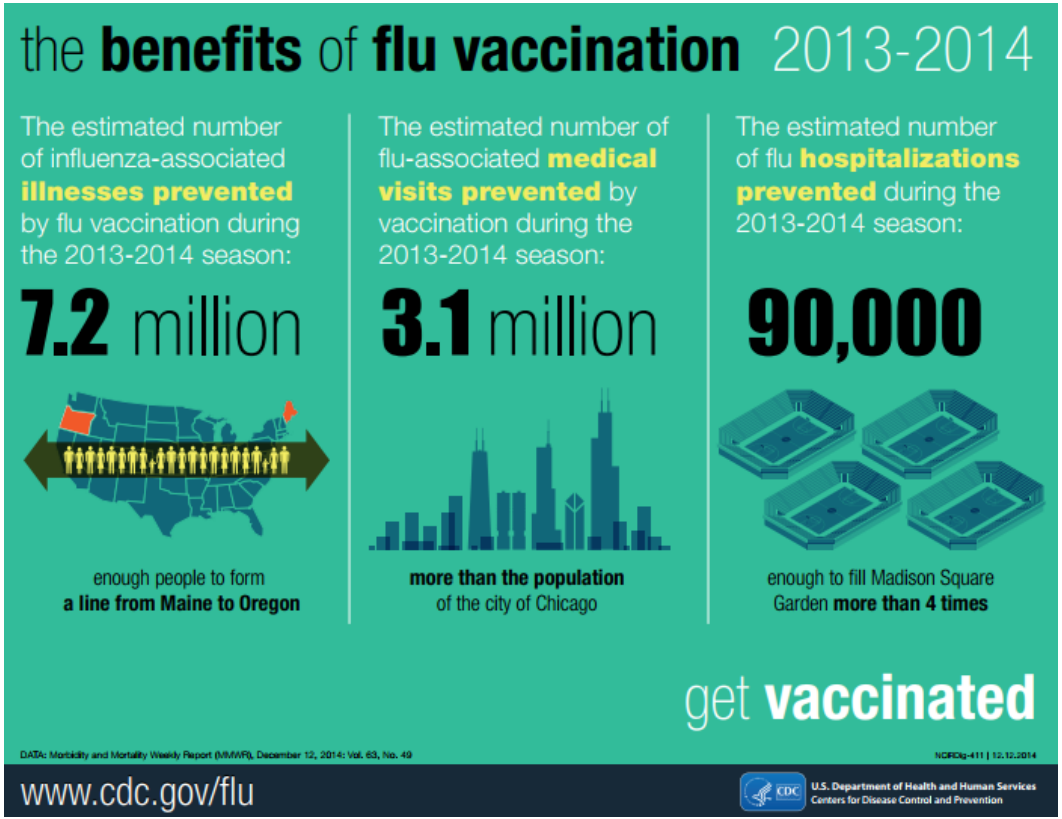
Example: Influenza

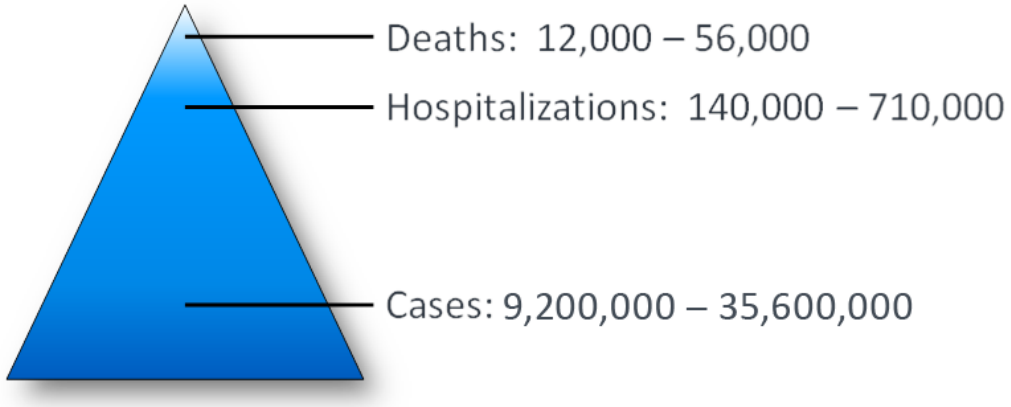
- 31.4 million outpatient visits
- 200,000 hospitalizations
- 45% of population vaccinated
- $87 billion in economic burden



https://www.cdc.gov/flu/pdf/freeresources/nivw-flu-vaccination-benefits-2013.pdf

Where do the costs come from?

- Prevention
- Treatments
- Time loss from work
- Doctor visits and hospitalization



https://www.cdc.gov/flu/about/disease/burden.htm

What does this mean for Immunoengineers?

- Prevention – e.g. vaccines, pathogen elimination
- Treatments – e.g. increasing efficacy, novel targets
- Time loss from work – e.g. pathogen containment
- Doctor visits and hospitalization - e.g. diagnostics