Managing the unimaginable

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For the class of 20.385

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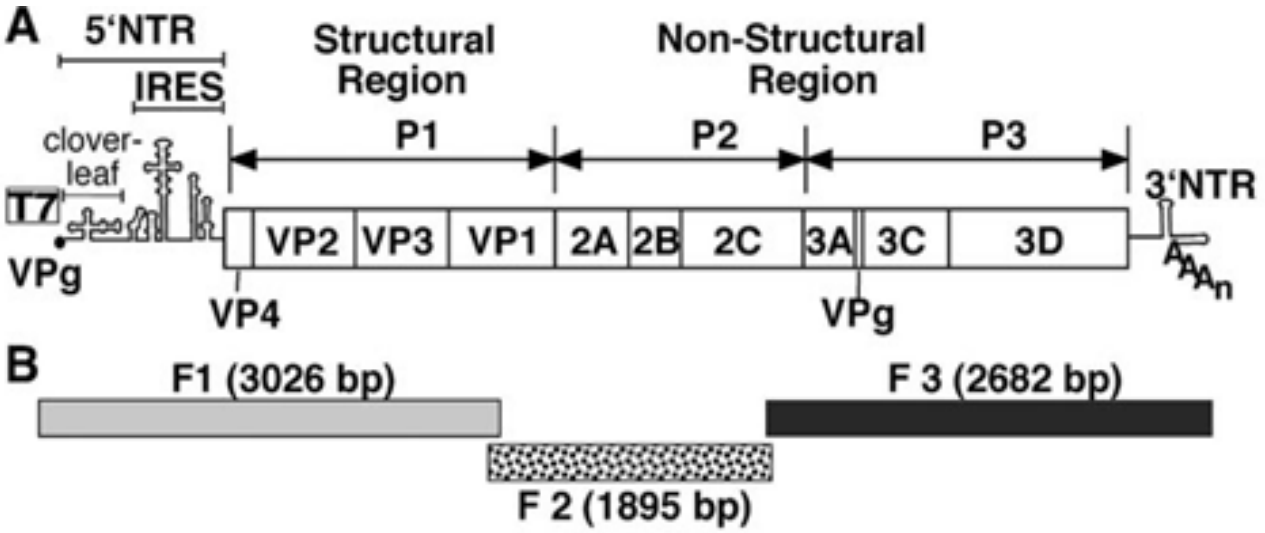
Synthetic Life Sciences

- Synthetic biology
  - Design of new biological parts
  - Engineering of known biological systems
- Synthetic genomics
  - Creation of new genes or molecules through arrangement of DNA molecules
- Able to affect many aspects of the environment
  - Drug development
  - Energy research
  - Biomedicine
  - Environmetal control

Polio

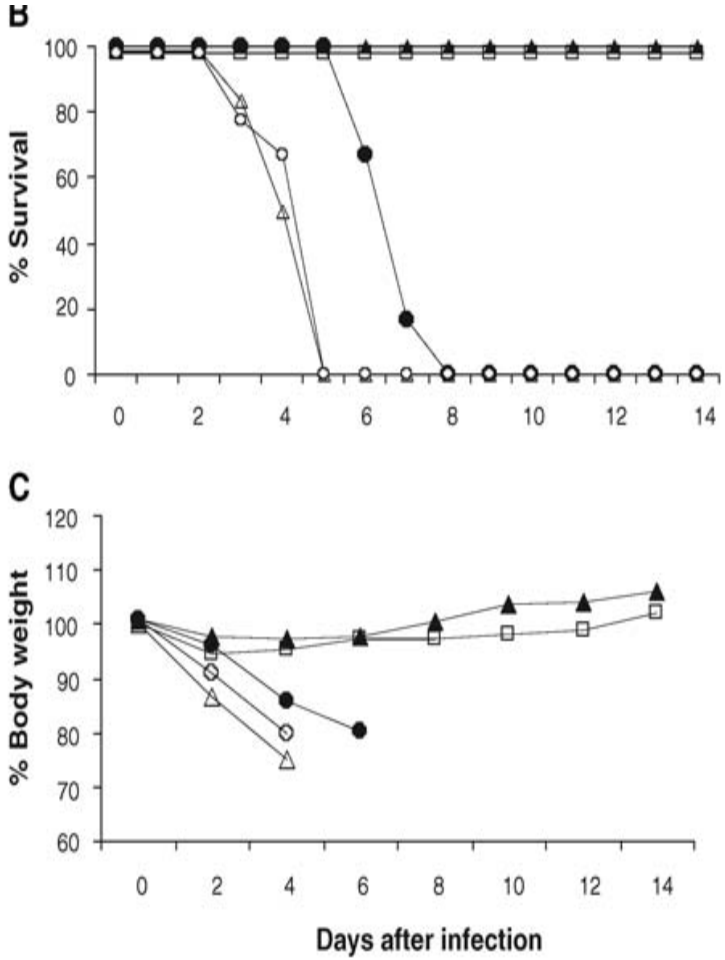


• Animals injected with synthesized strain of polio develop new neurological disease different from symptoms of wild-type polio

•Nucleotide substitutions inserted into the synthetic poliovirus gene cause silent mutations which show increased pathogenesis.

1918 Spanish Flu

- Constructed Spanish Flu strain tested against several strains of avian flue and H1N1.
- Survival drastically decrease in both mice and chicken eggs exposed to the virus.
- Identify essential toxic regions of virus that lead to mortality
- Assay drug effectiveness that are supplied and researched by CDC



History

Polio

- Worldwide epidemic between 1840s-1950s.
- Vaccine, but no cure
- Causes paralysis, muscle weakness, fever, etc.
- Prevalent in Asia and Africa

Spanish Flu

- 10-20 % of the people infected with the disease died
- 50 million people death toll (3 % of the population)
- Prevalent in the young and old
- No current vaccine or cure available.

Future Possibilities

- Designer viruses
  - Region dependent
  - Modified lag phases
  - Added forms of spread
- Resilient bacterium
  - Destroy ecosystems
  - Outcompete bodily resources

Pathogen Synthesis

- Problem
  - Experimentation on dangerous diseases, such as polio, influenza, ebola, etc.
  - Viruses with larger genome sequences can now be synthesized.
- Solution Requirement
  - Tight regulation of research data
  - Inherent Limitation
    - As information is more strict, less access means less research conducted world-wide, and less progress in the research.

Patents

- Problem
  - Patents on individual parts or on a whole system?
  - Gene patent struggles when used to create genome consisting of many genes.
- Possible Solutions
  - Strict enforcement of patent law
    - Discourages open research
  - Lose enforcement of patent law
    - Discourages industry participation and funding of private companies

Socioeconomic Restructuring

- Problem
  - Most synthetic research conducted by countries with the resources to do so
  - Different resources needed
  - Communities benefitting from research dependent on those resources
  - Research should "operate under social norms" and not "place social burden."
- Solution still unclear

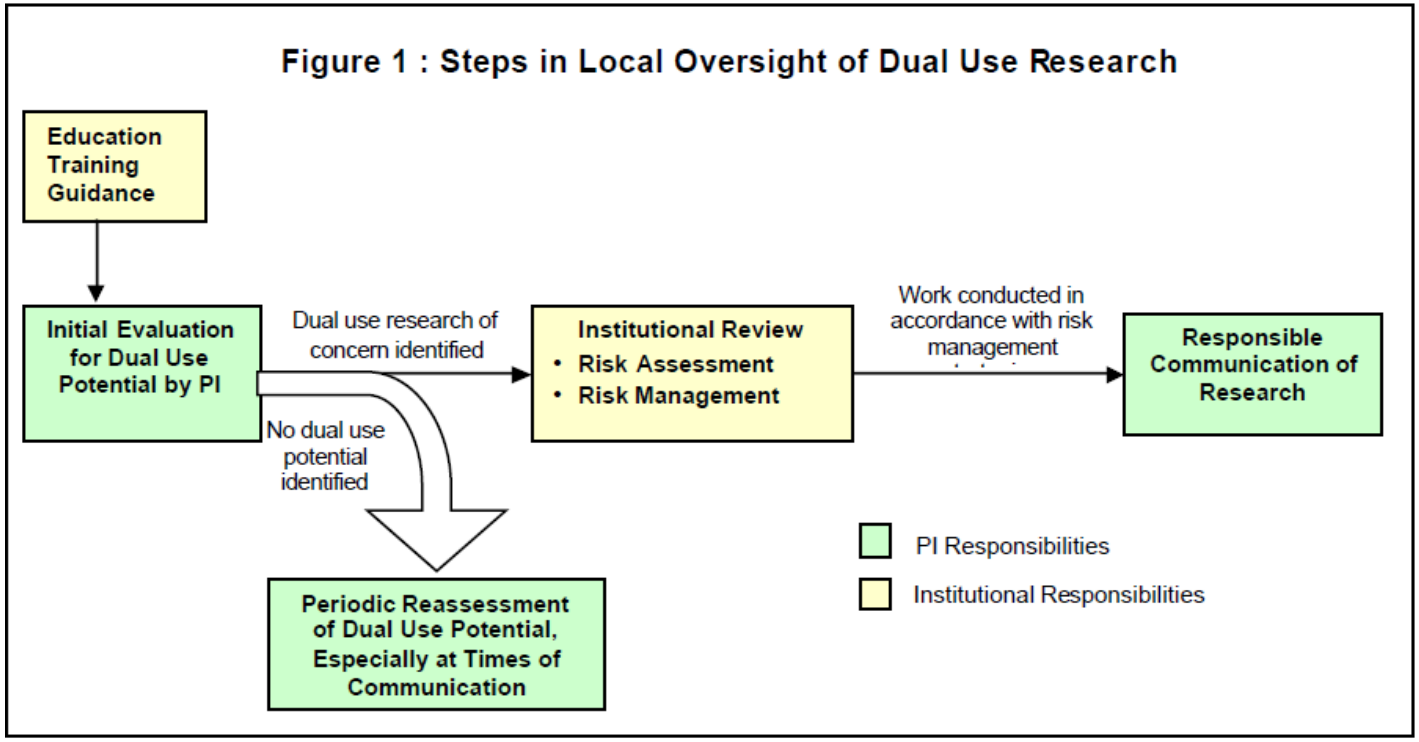
"Dual Use" Research

- Problem
  - Research can be applied to benefit or hinder man kind.
    - Famous examples: T.N.T. & Nuclear Power
  - Creation of pathogens
  - Bio-warfare
  - Prominent Institutions who do Dual Use Research
    - USAMRIID, CDC, JHU, BU, UCLA

Forms of Control

- Self governance vs. top-down governance
  - Argued that neither is fully appropriate
    - Top-down Government control too uninformed
    - Self-governance has too much interest in research
- Other forms of control
  - Oligonucleotide trade control
    - Basic building block, too small to determine purpose
  - Licensing and Registration
    - Large financial demand on the research sector
- NIH and the NSABB

Forms of Control (NSABB)



- National Science Advisory Board for Biosecurity
- Prevent negative consequences of "Dual Use" research

Forms of Control (NIH)

- Has NSABB as a branch to monitor Dual Use research
- Constantly redefine concepts and set guidelines
  - (ii) Synthetic nucleic acid molecules that are chemically, or by other means, synthesized or amplified, including those that are chemically or otherwise modified but can base pair with naturally occurring nucleic acid molecules
  - Consideration should be given to whether the drug-resistance trait to be used in the experiment would render that microorganism resistant to the primary drug available to and or indicated for certain populations, for example pediatric populations and pregnant women.
- BL-1, BL-2, BL-3, BL-4

Today

- Synthetic life science research conducted under top-down governance of NIH
  - Including pathogen research
    - Spanish Flu research in BL-3
- Need to redefine patent requirements
- Need to generate fitting socioeconomic policies

Darwin's Surprise

By: **Michael Specter**

Still being presented by: *José R. Echevarría*

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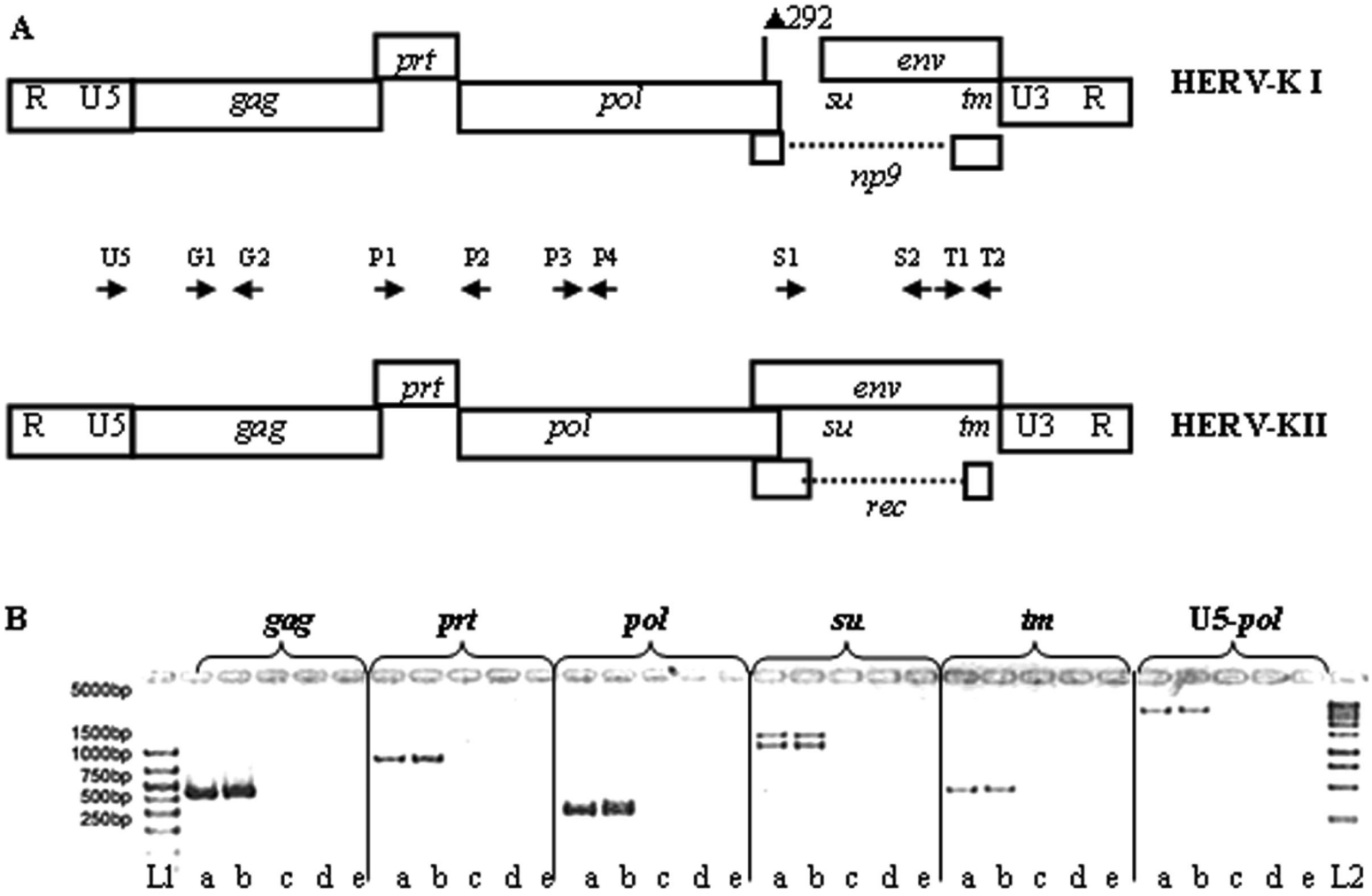
HERV-K(HML-2)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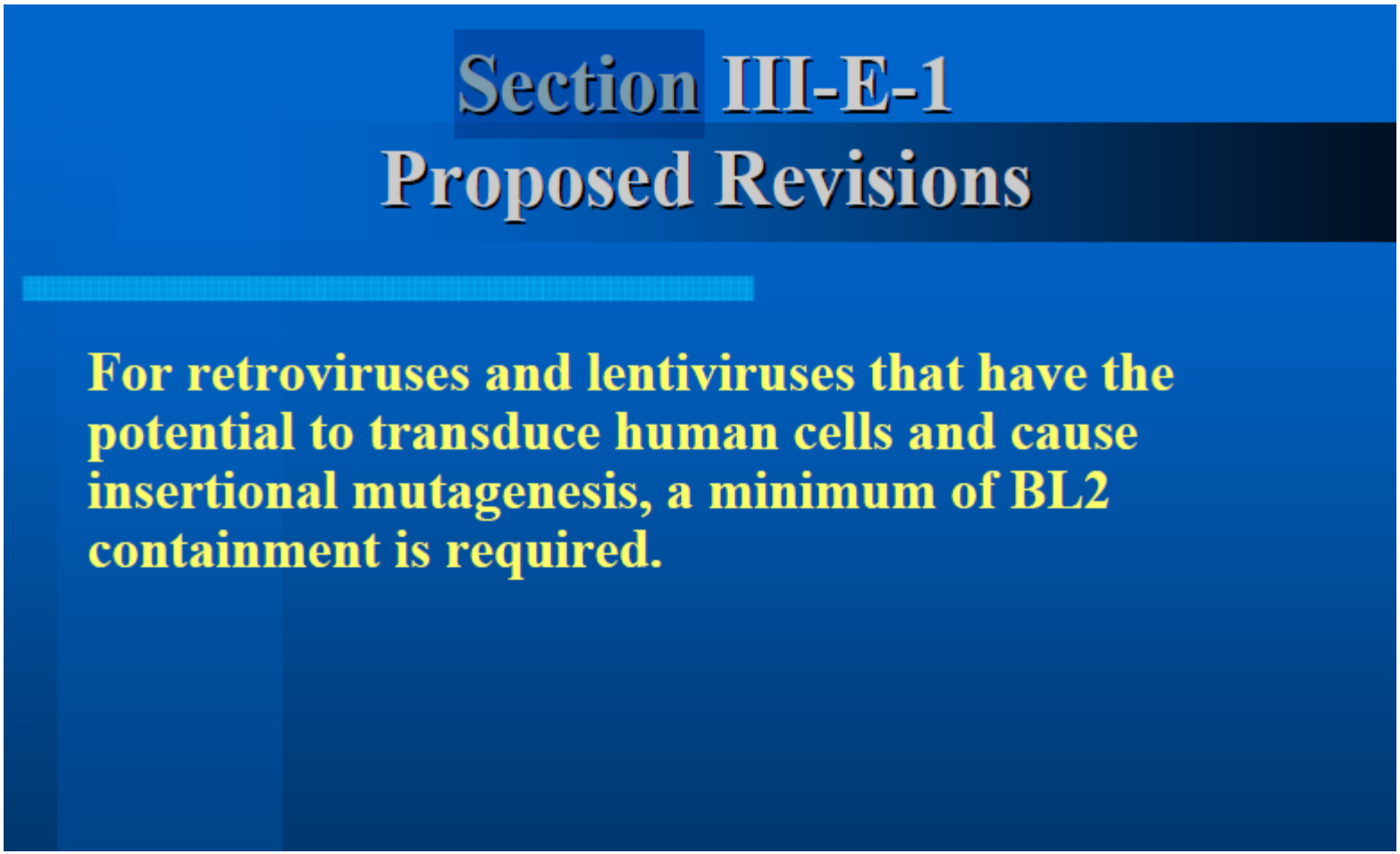
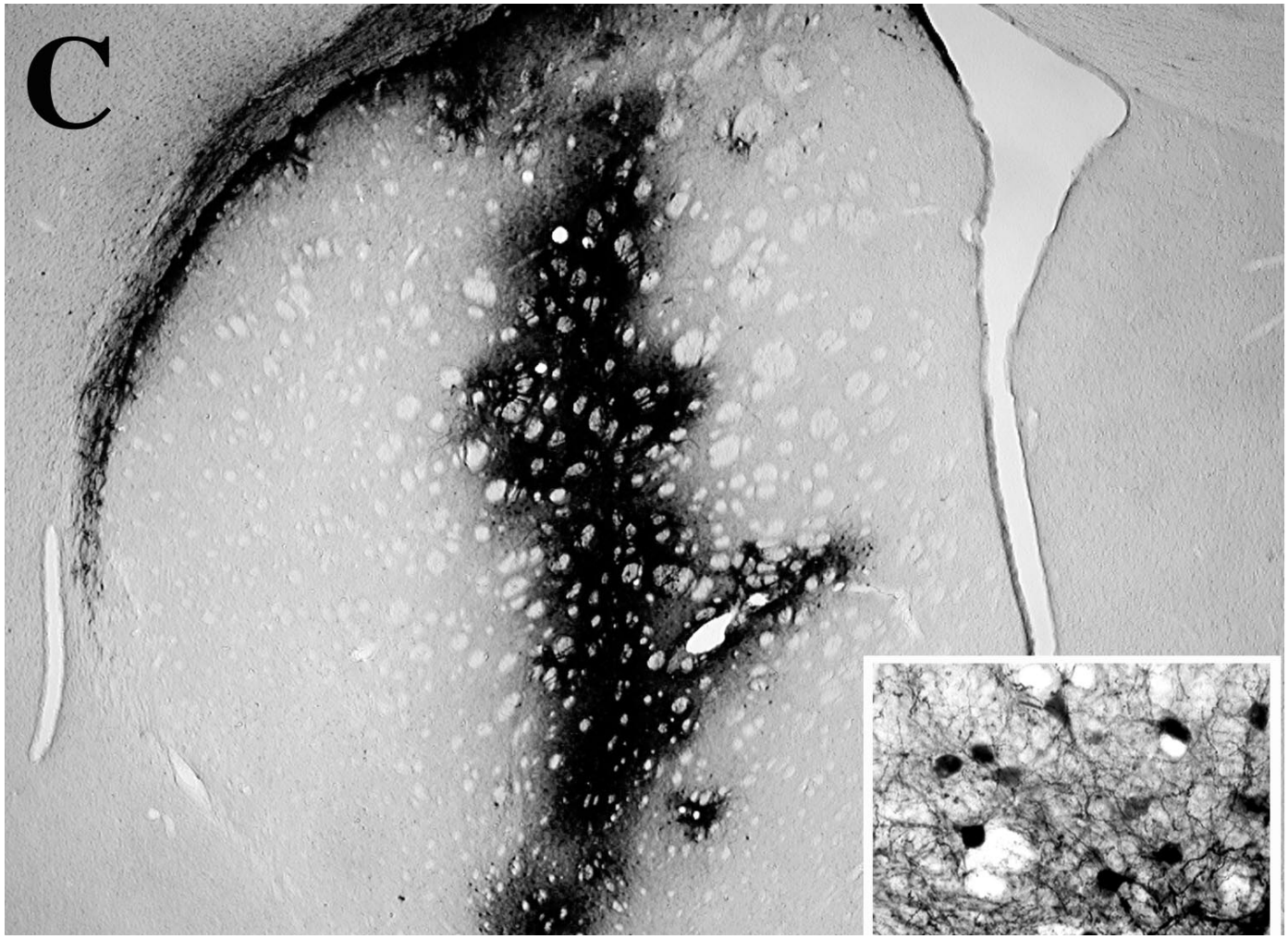
NIH and Retroviruses



Lentivirus Vectors



Retroviruses, friends or foes

- Cons
  - Infectious
  - Difficult to cure
  - Passed through genome
- Pros
  - Make good vectors for gene delivery
  - Research gives insight to current viruses (HIV)
  - Understanding of evolution