

# A Phylogenetic Analysis of the HIV-1 and HIV-2 Strains

## Initial Research Plan

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### Introduction / Rationale for Doing Project

HIV is a relatively new pandemic, responsible for causing AIDS and killing millions of people around the world. The two types of HIV known to cause AIDS, HIV-1 and HIV-2, have the same modes of transmission and clinical consequences. However, the two strains are very different in infection. HIV-2 is associated with lower viral loads and slower rates of CD4 decline, and as a result, HIV-1 is far more prevalent, accounting for a large proportion of AIDS cases.

Addressing these differences between the HIV-1 and HIV-2 strains using phylogenetic software may discover how and why these differences arise and how we can manipulate them to produce better treatments for HIV.

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### Hypothesis

By inspecting the genes of the HIV-1 and HIV-2 genome, it is hypothesized that, due to their many similarities in function, specific evolutionary relationships will be found between the two viruses and that these relationships can be expressed visually in the form of phylogenetic trees. It is expected that we will find how and why these differences arose and how they affect the virus's effectiveness.

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### Materials / Procedure

#### Materials

1. Modern computer with proper software downloaded and access to internet
2. A Nucleotide Database: [ncbi.nlm.nih.gov](http://ncbi.nlm.nih.gov) or [hiv.lanl.gov](http://hiv.lanl.gov)
3. Software
  - a. Download *KomodoEdit* (or any plain text editor), *Seaview*, *Mafft*, *Mesquite*, *BEAST*, *BEAUTi*, *Tree Annotator*, *Tracer*, *FigTree*

#### Procedure

1. Acquire all programs listed in "Materials".
2. Acquire data
  - a. Go to different nucleotide databases (e.g. [hiv.lanl.gov](http://hiv.lanl.gov), a database for HIV) and search for the necessary sequences.
  - b. Export a .fasta file with nucleotide sequences.
3. Aligning the File with *Seaview* / *Mafft*
  - a. Open the .fasta file in *Seaview*
  - b. Using the built-in alignment programs or *Mafft*, align the sequence
  - c. Optionally, you can manually adjust alignments with *Mesquite*

- d. Save aligned sequences in NEXUS format (.nex)
  4. Setting the Parameters for *BEAST*
    - a. Open the .nex file in *BEAUTi*
    - b. Separate the taxa into taxon sets depending on which sets are of interest
    - c. Set the dates of each taxa through "set tip dates" and setting them by hand
    - d. Click on Clock Models and change the Molecular Clock Model to a Strict Clock
    - e. Leave all else at the default settings unless you are willing to explore the other options that *BEAUTi* offers.
    - f. Click "Generate BEAST File" and an .xml file will be created.
  5. Input the .xml file into *BEAST* and click "Run".
    - a. When *BEAST* is finished, it will produce a log file and a tree file in the same location as your .xml file
  6. Open the log file in *Tracer*
    - a. *Tracer* provides various graphs and quantities that can be used to explore *BEAST*'s output
  7. Open the tree file in *TreeAnnotator*
    - a. *TreeAnnotator* can be used to modify and annotate the tree file
  8. Open the tree file in *FigTree*
    - a. *FigTree* can view, color and change the trees as the user wishes
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### Data Collection and Analysis

With all of our data, we would first analyze how accurate it is, using some sort of guideline or another computer program. After confirming that our data is backed well, we would move to make some conclusions.

By inspecting the trees made, we can analyze the changes in the two viruses. We can note similarities, times and areas of divergence, and then relate these differences back to HIV-2's weaker infections in comparison to HIV-1's. We can repeat the procedure with a focus on other genes or proteins to get more data to use.

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### Bibliography

- Baum, David. "Reading a Phylogenetic Tree: The Meaning of Monophyletic Groups." *Scitable*. NatureEducation, 2008. Web. 12 Oct. 2015.  
<<http://www.nature.com/scitable/topicpage/reading-a-phylogenetic-tree-the-meaning-of-41956>>. This article specializes in the reading and usage of an evolutionary tree, providing many illustrations to help detail the author's points. It goes over the different representations



of trees, and shows how although they look very different, they portray the same information.

Baum, David A., and Susan Offner. "Phylogenies and Tree Thinking." *American Biology Teacher* 70.4: 222-29. Print. This source provides an in-depth introduction to the concepts of phylogeny, going over basic definitions and terms while providing detailed examples with each topic. It is fairly accessible and goes into detail on mistakes that students make whilst analyzing trees, and how their use is more and more important in classrooms.

"Division of AIDS (DAIDS)." *National Institute of Allergy and Infectious Diseases*. Web. 12 Oct. 2015. <<http://www.niaid.nih.gov/about/organization/daids/Pages/default.aspx>>. This article provides basic information on the HIV virus, the HIV/AIDS epidemic, and what has been done so far to fight against it.

"Human Immunodeficiency Virus Type 2 (HIV-2)." *HIV Clinical Resource*. Web. 15 Nov. 2015. <<http://www.hivguidelines.org/clinical-guidelines/adults/human-immunodeficiency-virus-type-2-hiv-2/>>. This website provides an introduction to the HIV-2 subtype and talks about its history and effect on the human body. It also briefly discusses differences between it and the HIV-1 subtype as well as treatments for both viruses.

Nyamweya, Samuel, et al. "Comparing HIV-1 and HIV-2 Infection: Lessons for Viral Immunopathogenesis." *Wiley Online Library*. Web. 15 Nov. 2015. <<http://www.ncbi.nlm.nih.gov/pubmed/23444290>>. This article focuses on the differences between the HIV-1 and HIV-2 subtypes. It discusses differences in region, biochemistry, origin, and progression to AIDS. It also discusses how these differences could be used to better current treatment for HIV.

Thanukos, Anna. "Phylogenetic Systematics, a.k.a. Evolutionary Trees." *Understanding Evolution*. U of California Museum of Paleontology, 2006. Web. 12 Oct. 2015. <[http://evolution.berkeley.edu/evolibrary/article/phylogenetics\\_01](http://evolution.berkeley.edu/evolibrary/article/phylogenetics_01)>. This website provides further introductions into evolutionary trees, and defines various terms needed in the field. It also discusses the uses and applications of trees in modern-day biology.

## Checklist for Teacher/Adult Sponsor (1)

This completed form is required for ALL projects

To be completed by the Teacher/Adult Sponsor in collaboration with the student researcher(s):

Student's Name(s): Vivek

Bhupatiraju


Project Title: A Phylogenetic Analysis of the HIV-1 and HIV-2 Strains

- 1) ☒ I have reviewed the MSSEF/ISEF Rules and Guidelines and Ethics Statement.
- 2) ☒ I have reviewed the student's completed Student Checklist (1A) and Research Plan.
- 3) ☒ I have worked with the student and we have discussed the possible risks involved in the project.
- 4) ☐ The project involves one or more of the following and requires prior approval by an SRC, IRB, IACUC, or IBC:
- |   |  |
|---|--|
| <input type="checkbox"/> Humans             | Potentially Hazardous Biological Agents:   |
| <input type="checkbox"/> Vertebrate Animals | <input type="checkbox"/> Microorganisms <input type="checkbox"/> rDNA <input type="checkbox"/> Tissues |
- 5) Forms to be completed for ALL Projects:
- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Teacher/Adult Sponsor Checklist (1)   | <input checked="" type="checkbox"/> Research Plan      |
| <input checked="" type="checkbox"/> Student Checklist (1A)  | <input checked="" type="checkbox"/> Approval Form (1B) |
| <input type="checkbox"/> Regulated Research Institutional/Industrial Setting Form (1C) (when applicable after completed experiment) |  |
| <input type="checkbox"/> Continuation/Research Progression Form (7) (when applicable)   |  |

6) Additional forms required if the project includes the use of one or more of the following (check all that apply):

- ☐ **Humans** (Requires prior approval by an Institutional Review Board (IRB) and Scientific Review Committee (SRC))
- ☐ Human Participants Form (4) or appropriate Institutional IRB documentation
  - ☐ Sample of Informed Consent Form (when applicable and/or required by the IRB)
  - ☐ Qualified Scientist Form (2) (when applicable and/or required by the IRB)
- ☐ **Vertebrate Animals** (Requires prior approval, see rules)
- ☐ Vertebrate Animal Form (5A) - for projects conducted in a school/home/field research site (SRC prior approval required)
  - ☐ Vertebrate Animal Form (5B) - for projects conducted at a Regulated Research Institution. (Institutional Animal Care and Use Committee (IACUC) approval required prior to experimentation. SRC prior approval also required.)
  - ☐ Qualified Scientist Form (2) (Required for all vertebrate animal projects at a regulated research site or when applicable)
- ☐ **Potentially Hazardous Biological Agents** (Requires prior approval by SRC, IACUC, or Institutional Biosafety Committee (IBC), see rules)
- ☐ Potentially Hazardous Biological Agents Risk Assessment Form (6A)
  - ☐ Human and Vertebrate Animal Tissue Form (6B) - to be completed in addition to Form 6A when project involves the use of fresh or frozen tissue, primary cell cultures, blood, blood products and body fluids.
  - ☐ Qualified Scientist Form (2) (when applicable)
  - ☐ Risk Assessment Form (3) - required for projects involving protists, archae and similar microorganisms, for projects using manure for composting, fuel production or other non-culturing experiments, for projects using color change coliform water test kits, microbial fuel cells, and for projects involving decomposing vertebrate organisms.
- ☐ **Hazardous Chemicals, Activities and Devices** (Requires prior approval, see rules)
- ☐ Risk Assessment Form (3)
  - ☐ Qualified Scientist Form (2) (required for projects involving DEA-controlled substances or when applicable)

Janice Compton  
Printed Name of Teacher/Adult Sponsor

  
Signature

12/7/15  
Date of Review  
(Must be prior to experimentation.)

781-861-2320

jcompton@sch.ci.lexington.ma.us

Phone

Email



## Student Checklist (1A-Individual)

This form is required for ALL projects

Every student must fill out this entire form before beginning project experimentation. PLEASE PRINT OR TYPE.

Read the "Research Plan Instructions" on [www.scifair.com](http://www.scifair.com) before completing your Research Plan/Project Summary.

Contact the MSSEF Scientific Review Committee (SRC) by e-mail at [src@scifair.com](mailto:src@scifair.com) with any questions.

Project year includes research conducted over a maximum, continuous 12-month period between January 2015 and April 2016.

Student Name Vivek Bhupatiraju Grade 10  
Home Address 18 Constitution Road Apt #  City Lexington State MA Zip Code 02421  
Telephone 781-852-9799 Email Address vb7401@gmail.com  
School Name Lexington High School  
School Address 251 Waltham Street City Lexington State MA Zip Code 02421  
School Phone 781-861-2320  
Teacher Name Janice Compton Email Address jcompton@sch.ci.lexington.ma.us  
Project Title A Phylogenetic Analysis of the HIV-1 and HIV-2 Strains

1. Is this a continuation from a previous year? (Check one) ☐ YES ☒ NO  
If Yes:  
a) Attach previous year(s) ☐ Abstract and ☐ Research Plan  
b) Explain how this project is new and different from previous years on ☐ Continuation/Research Progression Form (7)
2. This year's laboratory experiment/data collection: (must be stated (mm/dd/yy) – Keep BLANK until experimentation starts and ends)  
Start Date:  End Date:
3. Where will you conduct your experimentation? (Check all that apply)  
☐ Research Institution ☐ School ☐ Field ☒ Home ☐ Other
4. List name, address, and phone number of all work site(s) other than school and home:  
Name:   
Address:   
  
Phone:
5. Complete a **Research Plan & Post-Project Summary** following the Research Plan & Post-Project Summary instructions provided and attach to this form.
6. An **Abstract** is required for all projects after experimentation.

## Approval Form (1B)

A completed form is required for each student, including all team members.

### 1. To be completed by Student and Parent

#### a) Student Acknowledgment:

- I understand the risks and possible dangers to me/my child of the proposed research plan.
- I have read the MSSEF/ISEF Rules and Guidelines and will adhere to all State and International Rules when conducting this research.
- I have read and will abide by the following Ethics Statement and the MSSEF Ethics Statement on [www.scifair.com](http://www.scifair.com)

Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs and the Intel ISEF.

Vivek Bhupatiraju

Student's Printed Name

*Vivek B.*

Signature

12/4/15

Date Acknowledged (mm/dd/yy)

(Must be prior to experimentation.)

**b) Parent/Guardian Approval:** I have read and understand the risks and possible dangers involved in the **Research Plan**. I consent to my child participating in this research.

Venkata Bhupatiraju

Parent/Guardian's Printed Name

*Venkata B.*

Signature

12/4/15

Date Acknowledged (mm/dd/yy)

(Must be prior to experimentation.)

### 2. To Be Completed by Fair SRC.

(Required for projects requiring prior Regional or State SRC APPROVAL.)

#### a) Required for projects that need prior SRC approval BEFORE experimentation

The SRC has carefully studied this project's **Research Plan** and all the required forms are included. My signature indicates approval of the **Research Plan** before the student begins experimentation.

\_\_\_\_\_  
SRC Chair's Printed Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date of Approval (mm/dd/yy)

(Must be prior to experimentation.)

Region: ☐ I ☐ II ☐ III ☐ IV ☐ V ☐ VI State: ☐

### 3. Final ISEF Affiliated Fair SRC Approval.

#### SRC Approval After Experimentation and Shortly Before Competition at Regional/State Fair

I certify that this project adheres to the approved **Research Plan** and complies with all MSSEF/ISEF Rules.

\_\_\_\_\_  
Regional SRC Chair's Printed Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date of Approval

\_\_\_\_\_  
State SRC Chair's Printed Name  
(where applicable)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date of Approval

**TEAM PROJECTS:** Each team member must fill out a separate Form 1B, which can be found by clicking here or visiting:  
<http://www.massscifair.com/fairs/high-school/manual-forms>

MSSEF/ISEF Forms 2015/2016

Full text of all rules and copies of forms are available at [www.scifair.com](http://www.scifair.com)