

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

Bhupatiraju

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

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, archaea 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 before completing your Research Plan/Project Summary.

Contact the MSSEF Scientific Review Committee (SRC) by e-mail at 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	781-652-9799	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: 12/7/16 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.

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

Initial Research Plan

Introduction / Rationale for Doing Project

The **human immunodeficiency virus**, or **HIV**, is a relatively new pandemic, responsible for causing AIDS and killing millions of people around the world. It is divided into 2 main types, HIV-1 and HIV-2. More well-known is the former; it is responsible for the vast majority of AIDS cases and has spread worldwide while HIV-2 is prevalent mainly in West Africa and is less pathogenic.

In order to track evolutionary relationships and rates/dates of divergence, scientists have created phylogenetic trees with both subtypes of HIV-1 and 2. In doing so, scientists have discovered that HIV evolved from **simian immunodeficiency virus**, or **SIV**, a closely related disease found in non-human primates.

However, many of the trees are of either low or unpublished bootstrap and/or posterior probability, both of which are indicators of a strong tree. Much focus has also been put on tracking the subtypes of HIV-1 and 2 more common in the Western world, and not so much in the rest of the world. As a result, we will attempt to create a well-supported tree with HIV-1, HIV-2 and SIV sequences from West Africa, an area of less study but an area with a large diversity of HIV subtypes.

Hypothesis

By inspecting West African HIV-1, HIV-2 and SIV genomes, it is hypothesized that information will be produced that ties together the three viruses in a well-supported phylogenetic tree. From the tree, it is expected that we will find evidence for relationships found in different regions as well as discovering some of our own new theories regarding the evolution of the virus.

Materials / Procedure

Materials

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

Procedure

1. Acquire all programs listed in “Materials”.
2. Acquire data
 - a. Go to different nucleotide databases (e.g. 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. Create Tree in PAUP*
 - a. Run Heuristic Search
 - b. Run Bootstrap Analysis
 5. 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 and are related to one another
 - c. Set the dates of each taxa through “set tip dates” and setting them by hand if needed
 - d. Click on Clock Models and change the Molecular Clock Model to a Strict Clock Model
 - 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
 6. 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
 7. Open the log file in *Tracer*
 - a. *Tracer* provides various graphs and quantities that can be used to explore *BEAST*'s output
 8. Open the tree file in *TreeAnnotator*
 - a. *TreeAnnotator* can be used to modify and annotate the tree file
 9. 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

After collecting the sequences and the trees, they would be analyzed by examining the bootstrap and posterior probability values generated, both of which determine the strength of a particular tree. If the tree is deemed to have sufficient support, we will try to make conclusions.

By inspecting the subtypes of HIV-1, HIV-2, SIV and their relationships within West Africa, we will attempt to find similarities with trees from other regions of the world. We will also attempt to discover new and undiscovered patterns; once found, we will then try to apply this knowledge to potential applications, like treatments for the virus or discovery of new subtypes.

Bibliography

- Baum, David. "Reading a Phylogenetic Tree: The Meaning of Monophyletic Groups." *Scitable*. Nature Education, 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>. 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.

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.

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

Vivek B.

12/14/15

Student's Printed Name

Signature

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

V.B.

12/24/15

Parent/Guardian's Printed Name

Signature

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.masscifair.com/fairs/high-school/manual-forms>