ND EPSCoR Lesson Plan Template

# Overview

## Lesson Title: Bioinformatics: Through the Lens of COVID-19

## Lesson Overview: In this lesson, the concept, technique and algorithm of bioinformatics will be introduced through a case study of COVID-19, which includes setting up a Linux operating system, downloading data and installing software in Linux commands, assembling SARS-Cov-2 genome.

## Lesson Objectives: After these lessons, the participants are supposed to

## Understand the concept and significance of bioinformatics

## Master the skills of setting up a Linux operating system

## Master basic Linux commands

## Understand de novo genome assembly

## NSF Subject Classification: Computer Science 400 Bioinformatics 26.1103

**National Next Gen Standards:** HS-ETS1-4 Engineering Design

**North Dakota Standards:** Computer Science and Cybersecurity K-12 Standards - 2019

**Grade or Grade Band:** K12: 9-12 Grades (High School)

**Time Needed (estimate):** 3 hours and 50 minutes for lessons, breaks (including lunch break) and a survey.

**Lesson Author:** Lu Liu, PhD, Department of Computer Science, North Dakota State University (email: lu.liu.2@ndsu.edu)

**Scientist/K12 Collaborator & University:** North Dakota State University, Other Collaborators listed as below:

September 20, 2020 Sitting Bull College (SBC)

October 4, 2020 Cankdeska Cikana Community College (CCCC)

November 15, 2020 Nueta Hidatsa Sahnish College (NHSC)

December 6, 2020 United Tribes Technical College (UTTC)

March 7, 2021 Turtle Mountain Community College (TMCC)

**Scientist Bio:** Dr. Lu Liu holds a Ph.D. in Computer Science from The University of Texas at San Antonio (2016), M.S. and B.S. in Computer Science from Beijing University of Posts & Telecommunications (2011 and 2008 respectively). His research interests lie in the broad area of bioinformatics, data mining, machine learning and computational biology. More specifically, his current research focuses on two areas: (1) machine learning methods for modeling and analyzing biological networks; (2) data mining approaches to biomarker discovery and disease prediction via integrated analysis of heterogonous "omics" data.

**Summary of Research and/or Problem Being Studied:** In this lesson, the participants will learn the concept, technique and algorithm of bioinformatics. They will set up a Linux operating system, use Linux commands to download SARS-Cov-2sequence data and install bioinformatics tools and learn de novo genome assembly by playing jigsaw puzzles.

# Preparation/Materials

**Background knowledge students must have to be successful:** Basic knowledge of computer and biology, computer operation experience

**Essential Terminology:** Bioinformatics, Operating System, Linux commands, Genome Assembly

**Resources:** Desktop or laptop computers with Wi-Fi access and permission to install software, Projector

**Websites:**

**Materials needed:** USB sticks, Jigsaw puzzles, worksheet

*PowerPoint – found as separate attachment*

# Procedure/Activities

## Lesson 1: Presentations on Bioinformatics (40 minutes)

## In this lesson, slides and a video will be presented to cover the concept of bioinformatics and basic facts of human genome.

## Activities: 1) Class survey

##  2) Working on questions on human genome and computer science

##  2) Dividing students into teams

## 3) Presenting slides and a video about bioinformatics

## 10 minutes break

## Lesson 2: Setting up a Linux operating system (30 minutes)

In this lesson, we will use PCs/laptops to create bootable USB sticks with Ubuntu by following this tutorial (<https://ubuntu.com/tutorials/tutorial-create-a-usb-stick-on-windows#1-overview>)

## Activities: 1) Presenting slides about Operating System

## 2) Hands-on experience of creating bootable USB sticks

## 30 minutes Lunch break

## Lesson 3: Downloading data and installing bioinformatics tools in Linux commands (45 minutes)

## In this lesson, we will use Linux commands to download SARS-Cov-2 sequence data and install bioinformatics tools, such as SRA toolkit.

## Activities: 1) Presenting slides about Terminal and Linux commands

## 2) Hands-on experience of running Linux commands

## 15 minutes break

## Lesson 4: Downloading data and installing bioinformatics tools in Linux commands (45 minutes)

## In this lesson, we will learn how to assemble SARS-Cov-2 genome.

## Activities: 1) Presenting slides on de novo assembly

## 2) Playing jigsaw puzzles

## 3) Hands-on experience of assembling genome SARS-Cov-2 by running Linux commands

## 15 minutes break

## Class Survey

## Extensions for above average students: In lesson 2, more Linux commands will be given to students who want to learn more about the Linux operating system. In lesson 4, students will be encouraged to explore UCSC Genome Browser on SARS-CoV-2.

## Mediation/Support for students that need it:

## Lesson Outline (for research-based lessons)

1. Observe Phenomena
2. What questions should we be able to answer?
3. Write a Hypothesis
4. Come up with a Research Plan
5. Carry out investigation
6. Revisit the Background Research
7. Construct Explanations. (TASKS-Publish/Communicate Findings)

# Standards Alignment

## ND Science Standard(s):

**Disciplinary Core Idea: e.g.** Life Science – cells and cancer (example is from SD EPSCoR lesson)

All living things are made of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.

**North Dakota DPI Standards:**

**Next Gen Standards:**

## Science and Engineering Practices

2. Developing and Using Models

## Cross Cutting Concepts

* Structure and Function

## Unit Objectives

* Students will be able to create a model in order to identify structures of a cell and cell membrane and the functions of each.

## Assessment

* When given a model of a cell membrane, students can identify the structures of the cell membrane and their functions. Students could construct a written explanation to compare and contrast the cell membrane function of a healthy cell versus a cancerous cell.

# Daily Plans and Assessments

## Learning Target for each day/activity

## After these lessons, the participants are supposed to

## Understand the concept and significance of bioinformatics

## Master the skills of setting up a Linux operating system

## Master basic Linux commands

## Understand de novo genome assembly

## Criteria for Success/Assessment for each activity

## After these lessons, the participants are supposed to

## Solve questions on the worksheet about human genome and bioinformatics

## Create a bootable USB stick

## Successfully download SARS-Cov-2 sequence data and install bioinformatics tools with Linux commands

## Successfully assemble SARS-Cov-2 sequence data with Linux commands

# Additional Lesson Resources / Materials

## References:

<https://www.youtube.com/watch?v=K9MqyU298uE>

<https://ubuntu.com/tutorials/tutorial-create-a-usb-stick-on-windows#1-overview>

[https://ubuntu.com/tutorials/command-line-for-beginners#1-overview](https://ubuntu.com/tutorials/command-line-for-beginners)

<https>[://genome.ucsc.edu/cgi-bin/hgGateway](https://genome.ucsc.edu/cgi-bin/hgGateway)

## Websites for purchasing materials