

Module 2: Coronavirus Science Jigsaw Activity on Coronavirus Mutations

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1. DESCRIPTION OF JIGSAW ACTIVITY

In this learning activity, students use a **jigsaw protocol** to investigate and analyze mutations in the genome of SARS-CoV-2, the virus that causes COVID-19. Students examine the various types of mutations that can occur in the viral genome and evaluate the impact of those mutations on the infectivity and transmissibility of SARS-CoV-2. In addition, students explore the question of whether these virus mutations will affect the efficacy of COVID-19 vaccines. Students demonstrate their understanding of the topic by creating a scientific communication strategy for SARS-CoV-2 mutations: a slide presentation, an infographic, a video, or a podcast.

All readings for this exercise are from media reports on COVID-19 and SARS-CoV-2. I have selected articles from different media outlets to provide students with a variety of reporting styles. However, reports from *The New York Times* are represented more frequently because of the quality of the reporting and the use of engaging graphics. Because this is a rapidly developing area of scientific study, instructors are encouraged to select and include additional media reports that have been released after the preparation of this jigsaw activity.

The stages of the jigsaw activity are outlined below:

STAGE 1: FOUNDATION

All students read **Media Report 1** on coronavirus mutations. Most students will not have prior knowledge of this topic, so the report provides a foundation for understanding the articles in the jigsaw activity. This reading can be assigned as a pre-class exercise. Students can use the **guiding questions** to identify the central points in the article. In addition, students are encouraged to identify **one question** they have that was not answered by the media report.

STAGE 2: EXPLORATION

Students are collected into groups and each student is assigned to read one report on SARS-Cov-2 mutations selected from **Media Report 2, 3, 4, or 5**. These reports examine the type of mutation and their effect on virus transmissibility, infectivity, and vaccine efficacy. As with Media Report 1, students can use the guiding questions to identify the main points of the article and ask their own unanswered question.

STAGE 3: INTEGRATION

After each student has read their article, the **jigsaw** component of the exercise involves students **integrating their knowledge** to arrive at a deeper understanding of coronavirus mutations. This goal is accomplished by students sharing insights from their media report, looking for areas of overlap, identifying areas of difference, and asking questions to fill the gaps.

STAGE 4: COMMUNICATION

Students will demonstrate their understanding of SARS-CoV-2 mutations by communicating their insights to their peers or other groups. Instructors can choose the format that is more appropriate for their class. The first stage of communication is an informal presentation to the class by each group or a sample of groups (depending on class size). The next stage can be the creation of a communication strategy to share information about SARS-COV-2 mutations using a slide deck, infographic, video, or podcast. Further details about each of these options are provided later in the document.

2. LEARNING OBJECTIVES

What should students know and be able to do?

- **Analyze** relevant information from media reports on COVID=19.
- **Understand** the genome of SARS-CoV-2.
- **Analyze** the types of mutations that can occur in the genome of SARS-CoV-2.
- **Evaluate** the effect of genome mutations on SARS-CoV-2 transmissibility, infectivity, and vaccine efficacy.
- **Create** a communication strategy to convey information about SARS-CoV-2 mutations.

Bold keywords in the learning objectives are taken from the revised (2001) version of Bloom's taxonomy.

3. FOUNDATIONAL READING

To provide background information, all students will read the following article before beginning the jigsaw activity.

MEDIA REPORT 1: How Coronavirus Mutates and Spreads

Jonathan Corum and Carl Zimmer

The New York Times

April 30, 2020

<https://www.nytimes.com/interactive/2020/04/30/science/coronavirus-mutations.html?referringSource=articleShare>

This report, written in the early phase of the COVID-19 pandemic, provides an overview of the RNA genome of SARS-CoV-2, plus an analysis of the mutations that happened to the original SARS-CoV-2 virus first identified in Wuhan, China. The report contains helpful graphical illustrations and provides an explanation of how changes in the base sequence of the RNA genome can produce mutations in the amino acid sequence of viral proteins. This report provides a valuable foundation for subsequent analysis of mutations in SARS-CoV-2.

Guiding Questions for Media Report 1

1. What type of molecule is used for the genome of the coronavirus that causes COVID-19?
2. What are the four letters used to represent the bases in the genome?
3. What is the size of the coronavirus genome?
4. How does the article describe the origin of coronavirus mutations?
5. What is the difference between a “silent” and a “non-silent” mutation? Provide one example of each type of mutation.
6. The first case of COVID-19 in the United States was confirmed in mid-January. How did scientists use genome mutations to identify the origin of the coronavirus?
7. Additional COVID-19 cases were found in Seattle in February. What did the analysis of mutations suggest about the origin of this coronavirus?
8. The article provides other examples of how coronavirus mutations were used to analyze outbreaks of COVID-19 within different regions in the world. Pick *one example* and describe how scientists analyzed the mutations.
9. Does the coronavirus mutate quickly or slowly? What is one reason for the rate of mutation?
10. After reading this media report, what is one question you have that was not answered?

4. READINGS FOR JIGSAW ACTIVITY

The jigsaw activity is based on the following four articles, which are assigned to individual students.

MEDIA REPORT 2: Massive Genetic Study Shows Coronavirus Mutating and Potentially Evolving Amid Rapid U.S. Spread

Chris Mooney, Joel Achenbach and Jo Fox

The Washington Post

September 23, 2020

<https://www.washingtonpost.com/health/2020/09/23/houston-coronavirus-mutations/?arc404=true>

This media report describes the identification of a variant of SARS-CoV-2, designated D614G, that contains a single amino acid change. This mutated virus has greatly increased in frequency among virus samples taken in Houston, Texas.

Guiding Questions for Media Report 2

1. How has a specific mutation in SARS-CoV-2 affected whether the virus is more or less contagious? How has the mutation affected whether the virus is more or less deadly?
2. The mutation discussed in this article is called D614G. In which virus protein does this mutation occur? What is this protein important? What does the designation “D614G” mean in terms of this protein?
3. Scientists speculate that the D614G mutation may make SARS-CoV-2 more transmissible. What scientific evidence is provided to support this hypothesis?
4. How does the biological principle of natural selection explain the spread of the D614G mutant virus?
5. One scientist mentioned in the article, Dr. Kristian Andersen, downplays the significance of the D614G mutation. Based on your analysis of the evidence presented in the article, do you think this mutation is important for understanding the spread of SARS-CoV-2. Why or why not?
6. After reading this media report, what is one question you have that was not answered?

MEDIA REPORT 3: What Do We Know About the Two New COVID-19 Variants in the UK?

Ian Sample

The Guardian

December 23, 2020

<https://www.theguardian.com/world/2020/dec/23/what-do-we-know-about-the-two-new-covid-19-variants-in-the-uk>

The Guardian is a newspaper published in the UK, so this article contains information about UK geography and policies. The media report describes two new variants of SARS-CoV-2 that were first described in December 2020.

Guiding Questions for Media Report 3

1. Why is there concern about two new variants of SARS-CoV-2 that have been discovered in the UK?
2. One of the virus variants arose in Kent, a county within the UK. Use the internet to find a map of the UK showing the location of Kent. Where is Kent located relative to London?
3. What is the source of the other variant of SARS-CoV-2?
4. How was the UK variant first discovered?
5. What mutations have been identified in the UK variant? Which protein in SARS-CoV-2 do these mutations mostly affect?
6. How does the other virus variant compare with the UK variant?
7. What do scientists hypothesize about the origin of the UK variant?
8. What evidence exists about whether the UK variant is more transmissible?
9. Does the UK variant cause COVID-19 to be more severe?
10. Do scientists think that the UK variant will impact the effectiveness of vaccines? How quickly could vaccines be changed if this becomes necessary?
11. After reading this media report, what is one question you have that was not answered?

MEDIA REPORT 4: The U.K. Coronavirus Variant: What We Know

Carl Zimmer and Benedict Carey

The New York Times

December 21, 2020

<https://www.nytimes.com/2020/12/21/health/new-covid-strain-uk.html>

This media report provides an analysis of the UK variant of SARS-CoV-2. It provides an interesting point of comparison to the article from *The Guardian*, which reports similar information. The article includes helpful graphics using the same style as those found in Media Report 1. Some of the guiding questions for this report overlap with questions for Media Report 3, although other questions are different to take advantage of the jigsaw format.

Guiding Questions for Media Report 4

1. What is the designation given to the UK variant of SARS-CoV-2?
2. How many genetic mutations have occurred in this UK variant of the virus?
3. Is the UK variant more contagious? What scientific evidence is used to answer this question?
4. Study the diagram showing the location of genome mutations in the UK variant of SARS-CoV-2. Make *one observation* about the types of mutations that exist in this variant?
5. Can the UK variant be contained by public health protocols like social distancing, wearing masks, etc.?

6. Does the UK variant cause more serious disease?
7. What do scientists hypothesize about the origin of the UK variant?
8. Will the UK variant make COVID-19 vaccines ineffective? Provide an explanation based on an important protein in SARS-CoV-2 that is affected by the mutations.
9. After reading this media report, what is one question you have that was not answered?

MEDIA REPORT 5: The COVID-19 Virus is Mutating. What Does That Mean for Vaccines?

Alice Park

TIME

January 7, 2021

https://time.com/5927538/covid-19-mutations-vaccines/?utm_medium=email&utm_source=sfmc&utm_campaign=newsletter+health-friday+default+ac&utm_content=+++20210108+++body&et rid=142155078

This media report examines the implications of SARS-CoV-2 variants for the effectiveness of vaccines. This reading connects the basic biology of SARS-CoV-2 (genomics, mutations, evolution) with the topics in Module 3 of the project, which focus on the immune response and vaccination.

1. Why are viruses prone to accumulating mutations?
2. How many total mutations has SARS-CoV-2 accumulated?
3. What was the first widespread SARS-CoV-2 variant? Is this variant susceptible to immunity induced by vaccines?
4. Describe a second SARS-CoV-2 variant. How does this variant affect the spread of the virus between people?
5. In a “worst case scenario,” how could SARS-CoV-2 become resistant to the immune cells generated by current vaccines?
6. What method can be used to track the evolution of SARS-CoV-2? Is this plan being implemented effectively in the U.S.?
7. What technology is used for current COVID-19 vaccines? How can vaccine manufacturers respond if SARS-CoV-2 becomes resistant to current vaccines?

5. ADDITIONAL READINGS

The following readings on SARS-CoV-2 mutations are more advanced and can be assigned as additional reading to appropriate student groups.

The Coronavirus is Mutating—Does It Matter?

Ewen Callaway

Nature

September 8, 2020

<https://www.nature.com/articles/d41586-020-02544-6>

Fast-spreading U.K. virus variant raises alarms

Kai Kupferschmidt

Science

January 1, 2021

https://science.sciencemag.org/content/371/6524/9?utm_source=Nature+Briefing&utm_campaign=6bfe441ebc-briefing-dy-20210104&utm_medium=email&utm_term=0_c9dfd39373-6bfe441ebc-42406971

Implications of the Emerging SARS-CoV-2 Variant VOC 202012/01

CDC, Centers for Disease Control

Updated December 29, 2020

<https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-emerging-variant.html>

Could Too Much Time Between Doses Drive the Coronavirus to Outwit Vaccines?

Meredith Wadman

Science

January 13, 2021

<https://www.sciencemag.org/news/2021/01/could-too-much-time-between-doses-drive-coronavirus-outwit-vaccines>

6. COMMUNICATION STRATEGIES

Students can deepen and demonstrate their understanding of SARS-CoV-2 mutations by working in a team to design a communication strategy to share their insights with peer groups or other target populations. Students can be given a choice of communication strategy.

Slide Deck

Students can prepare a slide deck (Google Slides or PowerPoint) to communicate their understanding of SARS-CoV-2 mutations.

Infographic

Students can use Canva to create an infographic about SARS-CoV-2 mutations. Further details on how to create an infographic are provided within this vaccine education project.

Video

Students can make a video presentation about SARS-CoV-2 mutations to communicate their understanding of this topic. Video creation is now easily accessible using smartphones. Short format videos like TikTok are still relatively new in science education, but researchers are exploring this medium to communicate with the public about COVID-19 vaccines.

Health Workers Are Going Viral on TikTok for Debunking COVID-19 Myths

Tara Law

https://time.com/5926397/health-workers-tiktok-covid-19/?utm_medium=email&utm_source=sfmc&utm_campaign=newsletter+coronavirus+default+ac&utm_content=+++20210106+++body&et rid=142225269

Podcast

Students can use their smartphones to record a podcast using an interview format or roundtable discussion.