

Lesson Plan: Impact of Climate Change on Circadian Rhythms and Sleep

Teacher-contributed lesson plan by Alaaeldin Ahmed Hamza, National Organization of Drug Control and Research, Egypt.

As a **High School Biological Sciences** or **Environmental Sciences** or **Health Sciences** teacher, you can use this set of computer-based tools to teach about **circadian rhythms** and the **factors** involved in maintaining the circadian rhythm in all living organisms. This lesson plan will discuss the impact of global warming on **sleep** in humans, which is as an integral part of their circadian rhythm.

This lesson plan will teach students about circadian rhythms and how they are important for the health and well-being of all living beings. Global warming is potentially causing a change in day and nighttime temperatures. This lesson plan includes resources to show how sleep is affected by higher nighttime temperatures and therefore, could lead to adverse impacts on human health due to a disruption in the circadian rhythm.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in **Biological Sciences** or **Environmental Sciences** or **Health Sciences**.

Use this lesson plan to help your students find answers to:

1. What are circadian rhythms? How are they related to sleep?
2. What are the factors involved in maintaining the circadian rhythm in living beings?
3. Why is the maintenance of circadian rhythms important for the health and well-being of individuals?
4. How is climate change affecting sleep and therefore the circadian rhythm in humans?

About the Lesson Plan

Grade Level: High School

Discipline: Biological Sciences, Environmental Sciences, Health Sciences

Topic(s) in Discipline: Circadian Rhythm, Biological Rhythms, Biological Clock, Photosensitive Ganglion Cells, Suprachiasmatic Nucleus (SCN), Sleep Disruption, Sleep Deprivation, Light Sensitivity, Body temperature

Climate Topic: Climate and the Anthroposphere

Location: Global, USA

Access: Online, Offline

Language(s): English, Spanish

Approximate Time Required: 30-40 min + 1-2 days

1 Contents

1. Video micro-lecture (~2.5 min)

A short video micro-lecture that introduces circadian rhythms and explains why it is important for living beings.

This can be accessed at:

<https://www.youtube.com/watch?v=2BoLqqNuqWA>

2. Reading (15 min)

A factsheet that defines circadian rhythm and explains its importance in influencing the physiology and behavior of humans. This tool is also available in Spanish.

This can be accessed at:

https://www.nigms.nih.gov/education/pages/factsheet_circadianrhythms.aspx

3. Video and Associated Reading (~5-7 min)

A video that describes a study about sleep disruptions in individuals in the USA because of higher nighttime temperatures due to global warming.

This can be accessed at:

<https://www.sciencemag.org/news/2017/05/scientists-warn-sleepless-nights-warming-world>

4. Classroom/Laboratory Activity (1-2 days)

A set of classroom or laboratory activities to explore biological rhythms in living organisms.

This can be accessed at:

<https://faculty.washington.edu/chudler/clock.html>

5. Suggested questions/assignments for learning evaluation

- What are circadian rhythms? How are they related to sleep?
- What are the factors involved in maintaining the circadian rhythm in living beings?
- Why is the maintenance of circadian rhythms important for the health and well-being of individuals?
- How is climate change affecting sleep and therefore the circadian rhythm in humans?

2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. Topic introduction and discussion

Use the video micro-lecture, '[What Makes You Tick: Circadian Rhythms](#)' by Oxford Sparks, Oxford University, to introduce the topic of circadian rhythms. Use this tool to explain why circadian rhythms are important for all living beings. Describe the role of photosensitive ganglion cells in the eye and the suprachiasmatic nucleus (SCN) in the hypothalamus of the brain, in managing the circadian rhythm. Explain that maintenance of the circadian rhythm in individuals depends on environmental cues such as light and that any disruptions can be detrimental to their health.

This can be accessed at:

<https://www.youtube.com/watch?v=2BoLqqNuqWA>

2. Extend understanding

Use this factsheet, '[Circadian Rhythms](#)' by National Institute of General Medical Sciences (NIGMS) to further your students' understanding of circadian rhythms. This tool is also available in Spanish. Use the text to differentiate between circadian rhythms and biological clocks. Define what is the master clock of the body and explain how it is responsible for keeping the circadian rhythm in sync with body physiology and behavior. Explain that circadian rhythms are influenced by both natural (genetic) and environmental cues such as daylight and in turn are responsible for body function and health. Use the text to explain how the body's master clock is responsible for establishing sleep patterns in individuals. Finally, discuss how disruptions in the circadian rhythm can lead to health problems.

This can be accessed at:

https://www.nigms.nih.gov/education/pages/factsheet_circadianrhythms.aspx

3. Discuss further

Use the video and associated report, '[Scientists warn of sleepless nights in a warming world](#)' by Ryan Cross, published in Science, to describe the effect of temperature on sleep cycles in individuals in the United States. Use the tools to describe the findings of a study that reports that global warming and the accompanying higher nighttime temperatures have resulted in insufficient sleep and sleep disruptions in individuals in the United States. Discuss the findings that the groups of poor and elderly individuals were more severely affected by this. Further, discuss how the results of the study suggest that with the current and predicted rate of global warming, more sleep cycle disruptions could happen, leading to lowered productivity and health problems in a larger proportion of the population.

This can be accessed at:

<https://www.sciencemag.org/news/2017/05/scientists-warn-sleepless-nights-warming-world>

4. Classroom/Laboratory Activity

Use the set of activities, '[Biological Rhythms](#)' by University of Washington, to enable students to explore their own biological rhythms in an engaging manner. In the context of this lesson plan, direct your students to follow the instructions for 'Experiment 1: The Ups and Downs of Body Temperature' to investigate the body temperature rhythm. Ask your students to do an additional activity from the 'reaction time' set of experiments for the same time-points. Use the data collected to correlate the body temperature noted at specific time-points and the corresponding reaction times. Use the correlation, if any, to discuss how warmer temperatures due to global warming could in turn affect body temperature related reaction times and therefore, biological rhythms in individuals.

This can be accessed at:

<https://faculty.washington.edu/chudler/clock.html>

5. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- What are circadian rhythms? How are they related to sleep?
- What are the factors involved in maintaining the circadian rhythm in living beings?
- Why is the maintenance of circadian rhythms important for the health and well-being of individuals?
- How is climate change affecting sleep and therefore the circadian rhythm in humans?

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- explain what circadian rhythms in living beings are and what influences them
- discuss the correlation of circadian rhythm and sleep cycles
- describe the importance of sleep cycles for the health and well-being of individuals
- explain how global warming could cause sleep deprivation and disruptions in humans

4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

1. Video

A video interview, 'Why is the circadian clock important? 2017 Nobel Prize in Physiology or Medicine' by Nobel Committee member Anna Wedell to explain the importance of the elucidation of the mechanisms of the circadian clock by the Nobel Prize Winners in 2017.

This can be accessed at:

<https://www.youtube.com/watch?v=OAsDkCs6Td4>

2. Audio Podcast

An audio podcast, 'Circadian Rhythm and Your Health' by Helmut Zarbl, PhD, National Institute of Environmental Health (NIEHS), to explain the importance of circadian rhythm for human health.

This can be accessed at:

https://www.niehs.nih.gov/research/supported/translational/peph/podcasts/2018/may17_circadian/index.cfm

3. Reading

A report, 'Research Sheds Light on How Climate Change May be Impacting Our Sleep' by Milken Institute School of Public Health, George Washington University, that summarizes the results of a review that investigated 16 studies pertaining to sleep impairment due to warming temperatures and other climate change associated weather conditions.

This can be accessed at:

<https://publichealth.gwu.edu/content/research-sheds-light-how-climate-change-may-be-impacting-our-sleep>

5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided. We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. Video micro-lecture; 'What Makes You Tick: Circadian Rhythms'

By [Oxford Sparks](#), Oxford University.

2. Reading; 'Circadian Rhythms'

By [National Institute of General Medical Sciences \(NIGMS\)](#).

3. Video and Associated Reading; 'Scientists warn of sleepless nights in a warming world'

By Ryan Cross, published in [Science](#).

4. Classroom Activity; 'Biological Rhythms'

By [University of Washington](#).

5. Additional Resources

[Nobel Prize YouTube Channel](#).

[National Institute of Environmental Health \(NIEHS\)](#).

[Milken Institute School of Public Health](#), George Washington University.