

Should athletes train outdoors?

Air pollution and cardiopulmonary health project for Human Anatomy & Physiology
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Course Context

Human Anatomy & Physiology (HAP) is a full-year science elective for 11th and 12th graders at Columbus School for Girls. These students have taken Biology and Chemistry and are either concurrently taking Physics or have already taken Physics. A few have already taken AP Biology or another AP science. HAP is taught in units that are each based around 1-2 body systems and each unit has a major project as its summative assessment. A unit is generally set to take 2-3 weeks of classes, which are 80-minute blocks every-other school day on a 6-day rotation (so some weeks the class is MWF, some TR). The respiratory and cardiovascular systems unit is currently taught after coverage of the musculoskeletal, nervous, digestive, and excretory systems, at the start of second semester. This means that students have already have had at least one primer on reliable scientific sources, data interpretation, how to give good presentations, and scientific citations.

Next Generation Science Standards Alignment

- HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Unit Learning Objectives

- Develop and explain a model that illustrates the structure and function of the respiratory system on multiple scales (from microanatomy to the entire organ system).
- Develop and explain a model that illustrates the structure and function of the cardiovascular system at the organ system level.
- Describe how function of the respiratory system integrates with the cardiovascular system.

Project Learning Objectives

- Explain how one type of air pollution affects the human cardiopulmonary system.
 - Possible choices for air pollution: ozone, particulate matter, sulfur dioxide, and nitrogen dioxide
- Explain how threshold recommendations regarding air pollution from the World Health Organization are based on an understanding of human cardiopulmonary anatomy and physiology.
- Identify the air pollution legislation currently applicable to one host city for a summer *or* winter Olympic Games and evaluate its effectiveness. Suggest one refinement to these regulations to improve human health.
 - Host city cannot be in the United States or Canada
- Draft recommendations for athletes looking to train in that city before a hypothetical Olympic Games happening in that city.

Overall Unit Outline

Day 1: Unit/project introduction

Day 2: Lecture/notes on cardiovascular system + Four-chambered heart digital activity

Homework: Cardiovascular System Model design sketches

Day 3: [Cardiovascular System Model challenge](#)

Day 4: Gallery walk for challenge models + [Anatomy in Clay](#) arteries of the arm

Day 5: Lecture/notes on respiratory system + Anatomy in Clay lungs (+ lung microscope slides?)

Day 6: Mini-experiments in cardiopulmonary physiology (measuring pulse, blood pressure, breathing rate, etc., in different contexts)

Day 7: Project work day

Day 8: Project presentations + class discussion to answer to the [Guiding Question](#)

Day 1

Timing	Activity Name	Activity Description
~5 min	Opening Survey	Ask students to raise hands in answering the following questions: <ul style="list-style-type: none">• Who spends time doing outdoor activities (hiking, camping, gardening, etc.)?• Who are athletes or exercise regularly?• Where do you train/exercise? Why do you choose that location?• Do you notice any difference in how you feel (physically, psychologically, etc.) outdoors vs. indoors?
15-20 min	Think-Pair-Share	Pose Guiding Question: Should athletes train outdoors? <ul style="list-style-type: none">• 3 min: write down list of factors that would contribute to/what you would need to know to determine an answer to this question• 5 min: compare/contrast answers with table partner; decide on top 3 factors• 5-7 min: every group shares top 3 factors with class and we develop comprehensive class list on board
20-30 min	Background	Introduce Unit Objectives Lecture on Air Pollution in the U.S. <ul style="list-style-type: none">• Major cities versus rural areas• EPA and the Clean Air Act• WHO air quality guidelines (2005)
15-20 min	Project Outline	Introduce project topic, project objectives, assessment format, assessment rubric

The following pages contain the documents that will be available to the students to explain the project and how it will be evaluated.

Human Anatomy & Physiology Unit 5 Project

Should athletes train outdoors?

For many athletes the Olympic Games are the pinnacle of sport. The modern Olympic Games started in 1894 with the establishment of the International Olympic Committee (IOC), who organized the Summer Olympics in 1896 in Athens, Greece. A lot has changed for humans in the past 124 years; athletes of the first Summer Olympiad did not have access to penicillin, plastic, credit cards, contact lenses, velcro, or ballpoint pens, not to mention airplanes or mass-produced automobiles. With these changes have come many improvements to humans' general quality of life, but there have also been consequences, particularly for human health.

Decreasing air quality due to air pollution has become a major concern as human populations have grown. Many of the largest cities around the world have or want to host an Olympic Games, but poor air quality in these cities is a major concern. Leading up to the 2008 Summer Olympics, [China invested \\$17.4 billion to reduce air pollution](#) in and around Beijing. Air quality became an issue again in Rio de Janeiro in 2016, when that city was being called the most polluted Olympic host city in at least 30 years and headlines touted "[Rio 2016: Rio de Janeiro's air more deadly than its water.](#)"

But why are we concerned about air pollution? What effects does it have on human health? And should athletes be particularly concerned?

In this project you will:

- Explain how one type of air pollution affects the human cardiopulmonary system.
- Explain how threshold recommendations regarding air pollution of that type from the World Health Organization are based on an understanding of human cardiopulmonary anatomy and physiology.
- Identify the air pollution levels and legislation currently applicable to one host city for an Olympic Games and evaluate its effectiveness. Suggest one refinement to the legislation to improve human health.
- Draft recommendations for athletes looking to train in that city before a hypothetical Olympic Games.

You will work in pairs and present your findings to the class at the end of the unit. After presentations, the class will work together to try to answer the question ***should athletes train outdoors?***

Part 1: Choose your pollutant and do background research

There are four major types of outdoor air pollution: ozone, particulate matter, sulfur dioxide, and nitrogen dioxide. For this project you will choose ONE of those pollutants to focus on.

Chosen pollutant: _____

Once you have chosen your pollutant you must do some background research in order to find out what levels of your pollutant the World Health Organization deem dangerous and the rationale for *why* those thresholds were chosen.

Use the questions below to guide your research. You will NOT turn in answers to these questions directly, but having this information on hand is what will allow you to build a complete model, explanation, and recommendations.

1. What are the WHO guidelines for your air pollutant? (Be sure to get specific units!)
2. What are the primary source(s) of your air pollutant?
3. What are the known adverse health effects of your air pollutant? At what exposure levels (concentration, time, etc.) do these adverse effects happen?
4. Are there any specific demographic groups that are more or less likely to experience adverse effects from this air pollution?
5. How does your air pollutant impact the respiratory system? (Be sure to consider both direct and indirect effects.) Are there specific anatomical structures that are more or less affected?
6. How does your air pollutant impact the cardiovascular system? (Be sure to consider both direct and indirect effects.) Are there specific anatomical structures that are more or less affected?
7. What, if anything, can people do to help prevent adverse effects when already exposed to this type of air pollution?
8. What can businesses and/or governments do to help reduce the prevalence of this air pollutant in the atmosphere in a given location?

Do not forget to keep track of your sources! You will need to cite any sources that you end up using in your final product in a separate [APA-style Reference List](#).

Also, be careful to properly vet your sources for reliability - pollution is a hot-button topic and so you may need to spend time [separating the wheat from the chaff](#), as it were. Remember, finding reliable sources now will save you headaches later!

Part 2: Create a model to explain the effects of air pollution on the human cardiopulmonary system

With your pollutant in mind, now you must develop a model of the human cardiopulmonary system through which you can demonstrate the effects of said pollutant to the class. In this context, what is a model? So glad you asked...

Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. Although models do not correspond exactly to the real world, they bring certain features into focus while obscuring others. All models contain approximations and assumptions that limit the range of validity and predictive power...

In science, models are used to represent a system (or parts of a system) under study, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. Students can be expected to evaluate and refine models through an iterative cycle of comparing their predictions with the real world and then adjusting them to gain insights into the phenomenon being modeled. As such, models are based upon evidence. When new evidence is uncovered that the models can't explain, models are modified. ([NSTA 2014](#))

Your model may be a drawing or diagram, digital or physical, 2D or 3D. However, it must show ALL of the following structures:

- Trachea
- Bronchus (*pl.* bronchi)
- Bronchiole (*pl.* bronchioles)
- Alveolus (*pl.* alveoli)
- Heart
- Pulmonary arteries and veins
- Systemic arteries and veins

The last two are only required as general vessels between the lungs and heart and heart and body, you do NOT need to name specific vessels (such as the aorta) or diagram capillaries. You could include those details, but should only be concerned with that level of detail if it specifically supports your explanation of the effects of your type of air pollution. Other optional anatomical structures include:

- Internal structure of the heart
- Lobes of the lungs
- Larynx
- Nasopharynx
- Diaphragm

Please note that Google Image Search is a sophisticated tool... if someone can input your model into that tool and get an exact or almost exact copy of your model, then you are on the wrong track. But do not fear! We will practice with making these types of models during this unit so constructing one on your own should be a less daunting task once you have a bit of practice.

Part 3: City-specific research and athlete recommendations

Lastly, you will focus in on a particular city, its pollution levels, its air pollution legislation, and how that could influence an athlete looking to train to compete outdoors in that city. The following cities are recent or future Olympic host cities, or have expressed interest in bidding (or have bid and failed) to be a host city in the near future. Note that the timing of your Olympic Games (winter or summer) may be important in your recommendations to athletes if air pollution in your city varies over the course of a year.

Winter Olympics

- Turin, Italy (host 2006)
- Sochi, Russia (host 2014)

- Pyeongchang, South Korea (host 2018)
- Beijing, China (host 2022)
- Almaty, Kazakhstan (failed bid 2022)
- Stockholm, Sweden (possible host 2026)
- Milan, Italy (possible host 2026)

Summer Olympics

- Beijing, China (host 2008)
- Rio de Janeiro, Brazil (host 2016)
- Tokyo, Japan (host 2020)
- Paris, France (host 2024)
- Bangkok, Thailand (failed bid 2008)
- Dubai, United Arab Emirates (failed bid 2016)
- Madrid, Spain (failed bids 2012, 2016, and 2020)

You will need to include the following in your presentation about your city and its air quality regulations:

- ★ The current air pollution levels in the city for your air pollution type
 - Do not worry about dates here - you do not need to try to find historical data on air pollution in Bangkok for 2008, nor do you need to try to extrapolate data to determine what air pollution levels will be in Beijing in 2022; we are just going to work with current measurements.
- ★ Whether being in summer/winter will make that number rise or fall (or stay the same)
- ★ A short description of any local, state/province, and/or national air quality laws that would apply to your city and your type of air pollution
- ★ Does your city meet WHO recommendations, on average, annually? What about the local/state/national laws you described above, does the city meet those?
- ★ Are there any efforts underway to improve air quality in that city? What are they? Based on your answer to the bullet point above, are these efforts effective?
- ★ What is one thing that the city, individual people, or businesses could do (that is not already happening) that would improve human health in relation to your chosen air pollutant?

Once you have the above information, you will need to make recommendations to an athlete planning to train in that city in the 6-12 months leading up to an Olympics there.

For your athletic recommendations you must include the following:

- Sport (you must choose one that competes *outside* during the Games... sorry swimmers!)
- Recommended location(s) and time(s) for training (can be time of day and/or time of year)
 - ◆ Your recommendations could include training indoors for an outdoor sport - but it probably is not the best training plan to ONLY include indoor training when competition will be outside...
- Recommendations on how long training should be (i.e. how long should outdoor exposure be during training?)
- Any recommended equipment (clothes, masks, eye protection, etc., that would help with that specific type of pollution)

(Be sure to explain your logic behind your choices for the last three bullet points and keep it relevant to your chosen air pollutant)

The Final Product

On the last day of the unit each team of two will give a short 5-7 minute presentation that achieves the following:

- Uses your model to explain the effect(s) of your type of air pollution on the human cardiopulmonary system
 - Describe the adverse effects of the pollutant, how are they caused in the body by the pollutant, and what, if any, specific group(s) are more susceptible
- Explains the anatomy and physiology behind the WHO recommended levels for your chosen air pollutant
- Summarizes the status of your air pollutant in your chosen city, how it relates to WHO recommendations and governmental regulations, what is currently being done, and one way that those regulations could be improved (all the starred bullets in Part 3)
- Identify the sport you chose and explain your recommendations about training (arrow bullets in Part 3)

The only hard copy item you MUST submit is an [APA-formatted Reference List](#). Other than that, you may choose to use PowerPoint or GoogleSlides, but you might also make a physical poster, 3D model, or use other “props” for your presentation without any digital part. The key is to make sure that you convey all the required content no matter what format you choose. If you do choose a digital slides format, be aware that I will expect you to show an effort towards [good presentation](#) design.

See the rubric on the next page for detailed information on how you will be assessed on the presentation.

The Final Decision

After every group has presented the class will come together as a group to consolidate that information into a general answer to the question **should athletes train outdoors?** We may develop certain caveats to our answer (only do ___ when ___), or we may be able to make more general statements - this will differ based on the group’s priorities and perspectives!

HAP Unit 5 Project Grading Rubric

Criteria for Proficient Performance	Score	Feedback
<p><i>Technical Content</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Demonstrates understanding of content <input type="checkbox"/> Uses technical language frequently & correctly in... <ul style="list-style-type: none"> <input type="checkbox"/> Model (includes all required parts) <input type="checkbox"/> Explanation of pollutant effects on organ systems <input type="checkbox"/> Anatomy/physiology of WHO guidelines <input type="checkbox"/> Air pollution legislation & effectiveness <input type="checkbox"/> Recommendations for athletes <input type="checkbox"/> Presents concepts at the same or deeper level than in class 	/35	
<p><i>Application of Research</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Topic is well-researched and addresses all project objectives <input type="checkbox"/> Data/research clearly drive... <ul style="list-style-type: none"> <input type="checkbox"/> Model design and construction <input type="checkbox"/> Explanation of pollutant effects <input type="checkbox"/> Explanation of WHO guidelines <input type="checkbox"/> Evaluation of effectiveness of air pollution regulations <input type="checkbox"/> Recommendations for athletes 	/35	
<p><i>Creativity, Design, & Style</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Model shows a creative approach <input type="checkbox"/> All aspects of presentation use good design techniques <input type="checkbox"/> Visuals are of high quality and well-organized <input type="checkbox"/> Information flows from one topic to the next during presentation <input type="checkbox"/> Correct grammar and spelling in any written portion 	/25	
<p><i>Citations</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Minimum 4 reliable resources <input type="checkbox"/> References List formatted in APA style <input type="checkbox"/> Hard copy of References List turned in (No in-text citations required.) 	/5	
<p><i>Timing</i></p> <p>-10% per day late</p>		

Total points:

/100

Resources (I haven't decided which of these will be made available directly to the students and which they will have to find on their own...)

- [WHO Air Quality Guidelines \(2005\)](#)
- [WHO Ambient Air Quality Database](#) (focuses on particulate matter)
- [Our World in Data: Air Pollution](#)
- [World's Air Pollution: Real-time Air Quality Index](#)
- [Air-quality.com](#) (data source for many cities across all types of air pollution - data extraction will be tedious, though)