

**Natural Sciences towards  
fostering human rights:  
hands on activities in Biology  
and Physics lessons**

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# INTRODUCTION TO THE WORKSHOP

- ❑ An important aim of education is to improve students' **thinking skills**, so that they become **reasoning** people.
- ❑ Reasoning processes are necessary both for their **academic achievement** and the skills they need in their everyday life, i.e. **everyday reasoning**.

(AAAS, 2000; CME, Canada, 1997; Dawson & Venville, 2009; Kuhn, 1993; Millar & Osborne, 1998; Sadler, 2004; Sadler, 2011).



# WORKSHOP' S THEORETICAL FRAMEWORK

- ❑ According to research in education and psychology, everyday human reasoning is based on **spontaneous** and **analytical** thinking.
- ❑ **Spontaneous** thinking is greatly influenced by peoples' existing beliefs -including prejudices-, which are formed through their prior interaction with their natural and social environment.
- ❑ **Analytical** thinking is based on objective evidence and logically documented conclusions.
- ➔ The ability to evaluate new evidence, once prior biases and stereotyped beliefs are eliminated, is a key component in fostering effective and advanced thinking  
(Evans, 2008; Evans & Curtis-Holmes, 2005; Kahneman & Frederick, 2005; Klaczynski et al., 1997; Stanowich, 1999).

- ❑ It is of great importance that, both, teachers and students need to acknowledge that **scientific developments** are **socially and culturally dependent** and are, constantly, transformed. In other words, science is a product of its time and place and might, sometimes, radically change - according people's multiple ways of thinking and acting.
  - ❑ For example, the theories of Galileo, Newton, Darwin and Einstein have changed our perception about humanity's place in the universe and precipitated enormous changes concerning the way people understand and deal with political, economic, historical and social issues (Hodson, 2010).
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- ❑ Thus, questions such as “How do we know?”, “Why do we believe?”, “What is the evidence for it?” are fundamental.
  - ❑ To explicit the aforementioned issues, this workshop will propose activities for science lessons, through which students’ analytical thinking (both, algorithmic and reflective), together with their ability to control spontaneous thinking can be developed.
  - ❑ It is expected that through the proposed material in which students’ analytical thinking can be enhanced, so that they can deal with social issues associated with **race** - and more specifically, discrimination in terms of **race**.
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# GUIDELINES

## FOR THE IMPLEMENTATION OF THE WORKSHOP

- ❑ Work in groups of 6.
- ❑ You have + + ++ minutes to work on the provided educational activities, given to each group.
- ❑ Write down your answers on the provided overhead transparencies.
- ❑ A member of your group needs to present the outcome of your work.







# CONCLUSIONS

- ❑ A priority needs to be put forward in pursuing students' ability to make judgements which eliminate biases, through Natural Sciences lessons.
  - ❑ This kind of advanced thinking presupposes **elimination of prior biases** -both in spontaneous and scientific thinking-, so that **new advanced -biased free knowledge- is produced.**
  - ❑ Both teachers and students need to **acknowledge their own pre-existing personal and scientific biases.**
    - ❑ It is recognized that this can be a **long and painful** process.
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# SUGGESTIONS FOR FUTURE EDUCATIONAL IMPLICATIONS

To fill in the **gap** that currently exists in fostering human rights education through natural sciences, it is suggested that:

- ❑ Clear learning objectives that enhance diversity in schools through Natural Sciences lessons need to be set.
- ❑ Teacher training focusing on issues of conflict need to be provided.
- ❑ New educational material which considers issues of diversity need to be produced.



- ❑ Difficulty in changing prior perceptions and beliefs, it can be seen in academia, in teachers and students. It is a really long and painful process. Fragmentation can be caused at any time. Thus, there is a need for **constant awareness and alertness**.
- ❑ There is also a fragmentation of knowledge between all stages of education: pre-school, primary, secondary and tertiary. Consistency needs to be established.





**THANK YOU VERY MUCH  
FOR YOUR ATTENTION AND COOPERATION!**



**Pestalozzi Programme**

**«Cha(lle)nging attitudes and actions for a diverse society: fighting prejudices and discriminatory bullying for equality through human rights: A cross - curricular approach».**

**Natural Sciences towards fostering human rights: hands on activities in Physics and Biology lessons**

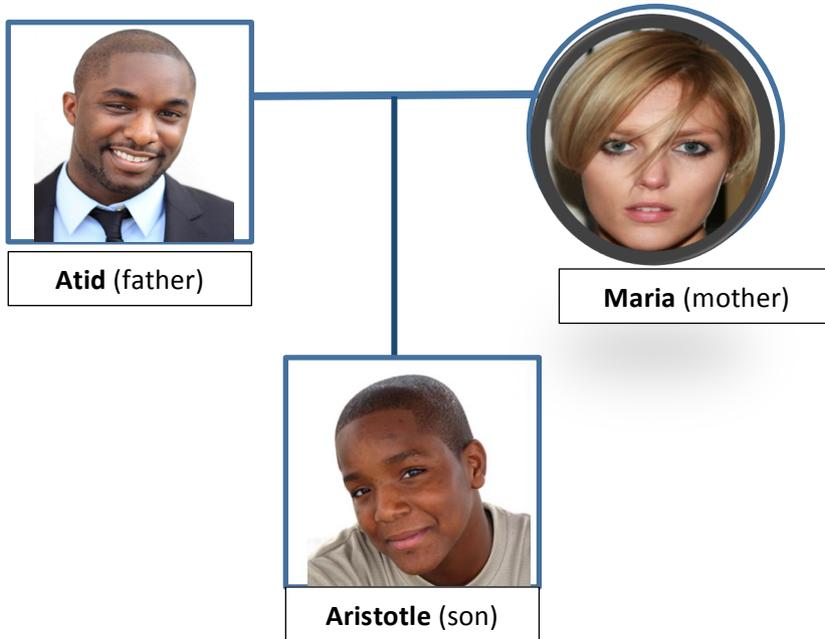
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Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

**Human Variation and Classification**

**Activities**

1. Look at Aristotles' family tree and answer to the questions that follow.



- In the table below, tick the name of Aristotle's parent from which you think he inherited his external features.

Aristotle's external features	Atid	Maria
• Skin colour		
• Hair colour		
• Nose shape		

- Complete the sentences:
  - All people are human. They, all, belong to the same species. Your friends and classmates may have different eye colour, skin colour, hair colour, etc. Some will become taller and others will stay shorter. The existence of differences between living organisms of the same species is called \_\_\_\_\_.
  - Variation between different species is always \_\_\_\_\_ than the variation within one species.
- Aristotle has black skin colour. What kind of variation has caused this?
  - Inherited variation
  - Environmental variation
  - Inherited and environmental variation
- How much of the genetic information needed for an individual, does a sperm cell contain?
  - All of the genetic information
  - Half of the genetic information
  - None of the genetic information
- How much of the genetic information needed for an individual, does an egg cell contain?
  - All of the genetic information
  - Half of the genetic information
  - None of the genetic information
- Complete the following sentences by matching each sentence from column A with the correct word from column B.

A/A	A
1.	A mixture of features is passed to us from our ...
2.	The term we use to describe how we acquire these features is called ...
3.	These features are known as...

B
inheritance.
inherited variation.
parents.

- Connect the words from column A with their description in column B.

A/A	A	B
1.	Environment	Something that changes an organism
2.	Environmental factor	Part of an organism has changed because of its surroundings
3.	Environmental variation	The surroundings of an organism

**2. Read the following scientific information about human skin colour and then answer the questions 2.1 and 2.2.**

When humans moved into hot environments in search for food and water, they had to face the big challenge to be kept cool. Their body was adapted by increasing the number of their sweat glands on the skin, and at the same time by reducing the amount of their body hair. With less hair, perspiration could evaporate easily and cool the body efficiently. But this less-hairy skin was -still- a problem because it was exposed to a very strong sun; especially in lands near the equator. Since strong sun exposure damages the body, the solution was to evolve skin that was permanently dark, so as to protect them against the sun's damaging rays. To this adaptation, melanin had an important role.

Melanin -the skin's brown pigment- is a natural sunscreen that protects tropical peoples from the harmful effects of ultraviolet (UV) rays. UV rays can, for example, strip away folic acid, which is a nutrient essential to the development of healthy foetuses. This delicate balancing act explains why people that migrated to colder geographic zones with less sunlight developed lighter skin colour. When people moved to areas further away from the equator with lower UV levels, natural selection favoured lighter skin, which allowed UV rays to penetrate. Peoples' dark skin living closer to the equator was important in preventing folate deficiency.

Finally, there is a third factor which affects skin colour: a certain amount of UV rays penetrates the skin, it helps the human body use vitamin D to absorb the calcium necessary for strong bones. As people moved to areas farther from the equator with lower UV levels, natural selection favoured lighter skin which allowed UV rays to penetrate and produce essential vitamin D. Specifically, coastal peoples -who eat diets rich in seafood- will get more vitamin D. Thus, some Arctic peoples -such as native peoples of Alaska and Canada- can afford to remain dark-skinned - even in low UV areas. In the summer, they get high levels of UV rays reflected from the surface of snow and ice and their dark skin protects them from this reflected light.

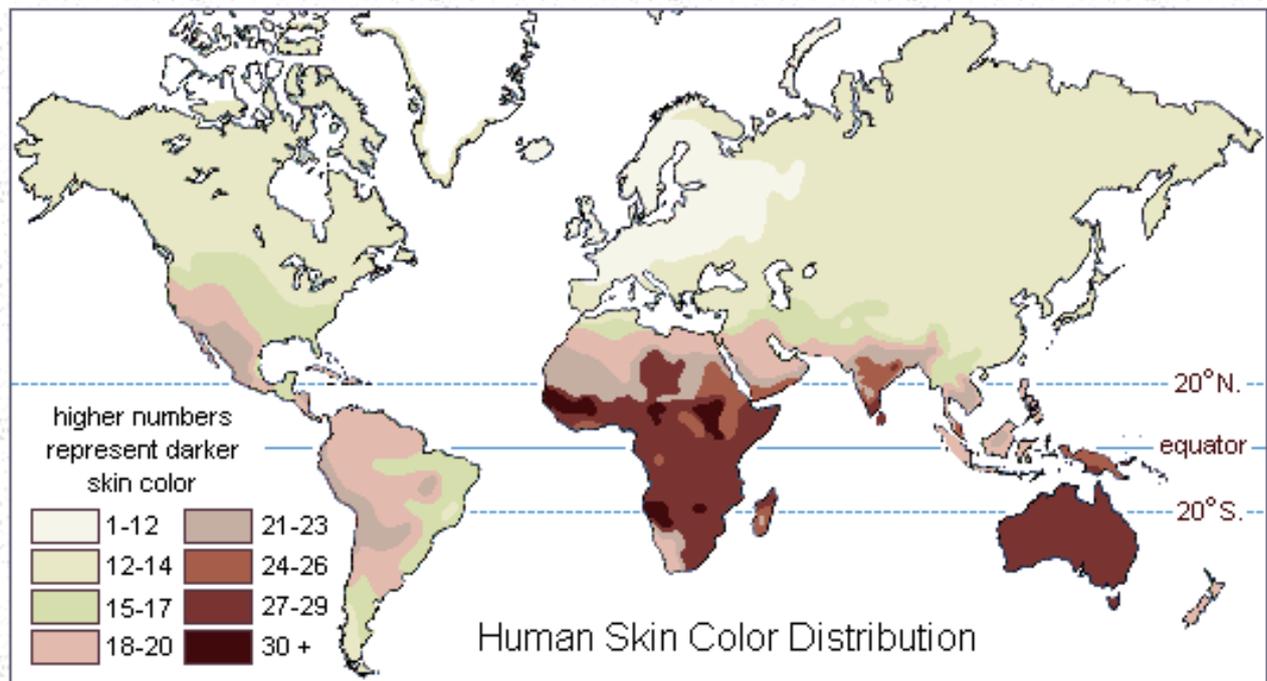
**2.1.** Explain why people from different parts of the world have different skin colour.

**2.2.** Explain why people from the tropics, in general, have darker skin colour than those living in colder climates.

3. **Skin colour is one of our most visible physical features, which has extensively been used to divide people into race categories (e.g. Caucasian, Mongoloid, Negroid). Additionally, over the past two centuries, science has been - occasionally- used to support that differences in achievement are in accordance with the inherited abilities that each race group possesses. By the mid-20th century and the end of World War II, this theory has lost most of its scientific credibility, but -also- its social and political power. However, it has -never- been entirely abandoned.**

3.1. Nowadays, some people use skin colour as a parameter to understand social, cultural and political variation in humans. Explain to what extent you agree with this way of thinking and acting. Support your opinion by giving three arguments.

3.2. Some people believe that **intelligence** is a human characteristic that defines high achievement. Specifically, they interpret existing gaps in achievement between social groups in relation to race. However, others argue that these gaps exist due to social inequalities and not race. Support your opinion by giving two arguments.



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***Melanin: Natural Sunscreen***

UV light is harmful to living organisms because it causes changes (i.e., mutations) in the DNA sequence. Skin cells that produced a pigment called melanin were advantaged because melanin is a natural sunscreen; it absorbs the energy of UV light and shields cells from the radiation's harmful effects. Such cells were favored in evolution and now all human skin cells can produce this pigment.

People vary in their skin tone due to differences in the distribution, quantity, size, and type of melanin found in their skin cells. As you might suspect, people with dark skin tend to have larger and more numerous melanin-containing particles in their skin. This provides protection from the sun's UV rays. Many genes are known to affect the production of melanin and cause skin color variation in humans. While skin color is an inherited characteristic, the fact that many genes code for this trait explains why children do not always exactly match their parents' skin tone. Tanning is the process of producing more melanin in the skin in response to ultraviolet exposure, and does not require a change in the genetic code (if a parent gets a tan, the offspring will not be more pigmented).

***Distribution of UV Light across the Globe***

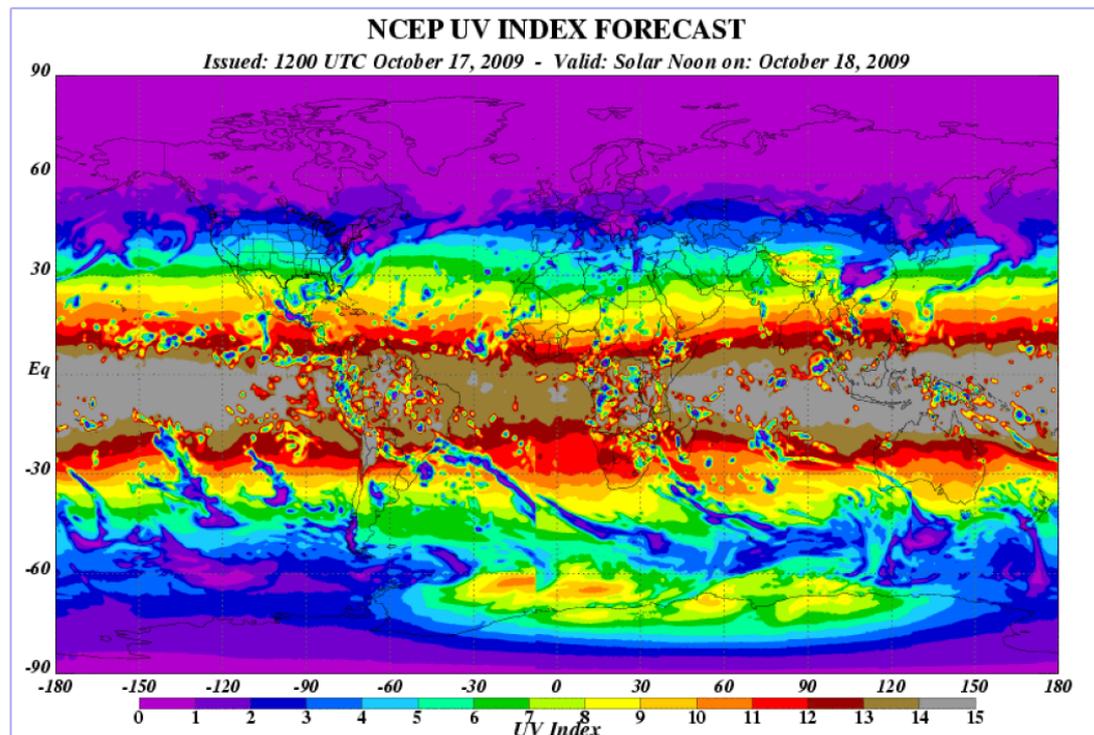
The following image (Figure 1) represents a map of the world on which the UV-light Index has been superimposed. The latitudes are shown on the left (latitude helps define a location on Earth, specifically how far north or south of the equator a site is).

**Questions**

1. Does the amount of UV light reaching the Earth vary in a predictable manner? If so, describe the pattern you observe.
2. What latitude receives the greatest amount of UV light? The least?

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3. Based on these data, where might you expect to find the most lightly pigmented and most darkly pigmented people on the planet? Be as specific as you can.
4. Provide a rationale to your answer above (i.e., why did you think that more darkly pigmented people would be found in those areas)?

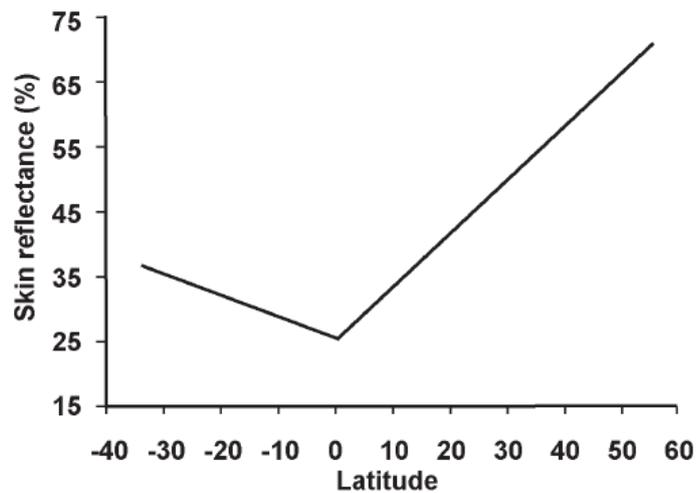


Source: Figure obtained from the National Oceanic and Atmospheric Administration. Graph retrieved from [http://www.cpc.ncep.noaa.gov/products/stratosphere/uv\\_index/gif\\_files/uvi\\_world\\_f1.gif](http://www.cpc.ncep.noaa.gov/products/stratosphere/uv_index/gif_files/uvi_world_f1.gif)

### Distribution of Skin Tones across the Globe

Let's examine whether our predictions were correct. Figure 2, shows the relationship between latitude and the average skin reflectance of populations located throughout the world. Skin reflectance is a measure of pigmentation. The more a skin reflects light, the lighter it is in tone.

Figure 2: Relationship of skin reflectance to latitude.



Source: Panel B of Figure 2 in Barsh (2003). Graph originally captioned as “Summary of 102 skin reflectance samples for males as a function of latitude, redrawn from Relethford (1997).” © 2003 Public Library of Science. This is an open-access article distributed under the terms of the Public Library of Science Open-Access License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

### Questions

1. Interpret this graph and the trend it describes.
  - a. Is skin reflectance randomly distributed throughout the globe? If not, how would you describe the pattern?
  - b. Restate your findings in terms of skin color and UV light (instead of skin reflectance and latitude).
  - c. Some populations have skin colors that are darker or lighter than predicted based on their location (their data point falls somewhere outside of the line shown in Figure 2). What might explain the skin color of these exceptional populations? Propose a few hypotheses.
2. Hypothesize why different skin colors have evolved. Based on what you know, what factor is most likely to exert a selective pressure on skin color?

### **Vitamin D3: Still Another Way of Looking at It**

Vitamin D3 is essential for normal growth, calcium absorption, and skeletal development. It is particularly important in maintaining and repairing healthy bones and teeth. Its role in calcium absorption makes it essential in maintaining a healthy heart, blood clotting, a stable nervous system, and an effective immune system. Deficiencies manifest themselves as rickets (softening of the bones), osteoporosis, and osteomalacia. It can lead to death, immobilization, or deformities. Women have a higher need for this nutrient during pregnancy and lactation due to their need to absorb calcium to build the fetal skeleton.

Humans can obtain vitamin D3 by one of two means. They can consume it in certain foods (fish liver oil and, to a lesser extent, egg yolk are good sources). Alternatively, skin cells have the ability to synthesize it from a cholesterol-like precursor. However, this process requires the energy of UV radiation.

Theoretical research on the dose of ultraviolet radiation required to produce vitamin D3 suggests that for moderately to darkly pigmented individuals (Figure 5):

- There is enough sunlight reaching the tropics to meet all of a human's requirement for vitamin D3 throughout all months of the year. This is indicated by the dotted area on the map.
- In the area indicated by narrowly-spaced obliques, there is *not enough* ultraviolet light to synthesize vitamin D3 in human skin for at least 1 month of the year;
- In the area indicated by widely-spaced obliques, there is *not enough* UV light for the skin to synthesize vitamin D3 in any month of the year.

Figure 5. Amount of UV light available to synthesize recommended levels of vitamin D for a moderately to darkly pigmented person at various locations around the world.



Source: reprinted from *The Journal of Human Evolution* 39(1), Jablonski, N.G., and G. Chaplin, The Evolution of human skin coloration, pp. 57–106, Figure 2, copyright (2000), with permission from Elsevier. <http://www.sciencedirect.com/science/journal/00472484>.

### Questions

1. Which skin tone allows someone to maintain the recommended level of vitamin D3?
2. Taking only vitamin D into consideration, what would happen to the reproductive success of:
  - a. A light-skinned person living in the tropics?
  - b. A light-skinned person living in the polar region?
  - c. A dark-skinned person living in the tropics?
  - d. A dark-skinned person living in the polar region?
3. Predict the skin tones expected at different latitudes, *taking only* vitamin D needs into consideration. Use the world map (Figure 6) to indicate the skin tone expected at each latitude (shade a region to represent pigmented skin in that population).

Figure 6. Map of the world.



Source:[http://commons.wikimedia.org/wiki/File:World\\_map\\_blank\\_black\\_lines\\_4500px\\_monochrome.png](http://commons.wikimedia.org/wiki/File:World_map_blank_black_lines_4500px_monochrome.png), CC BY-SA 3.0.

4. Can vitamin D3 alone explain the current world distribution of skin color?

Evolution by natural selection is a process of compromise in which costs are minimized and benefits are maximized. Both light and dark skins have costs and benefits. As you are probably now realizing, adopting one level of pigmentation has trade-offs.

5. Using principles of natural selection, predict the skin tone expected at different latitudes, taking *ultraviolet exposure and vitamin D* into consideration. Use the map (Figure 7) to indicate skin tone patterns at different latitudes (shade regions where populations are expected to be darkly pigmented).

Figure 7. Map of the world.



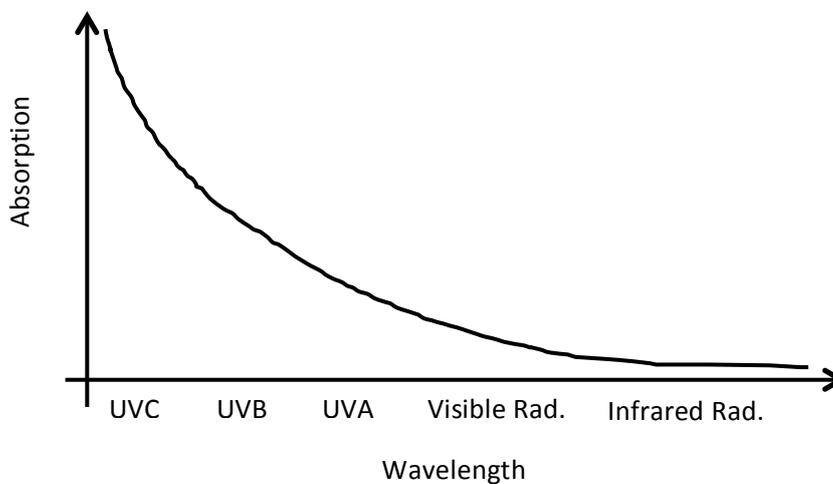
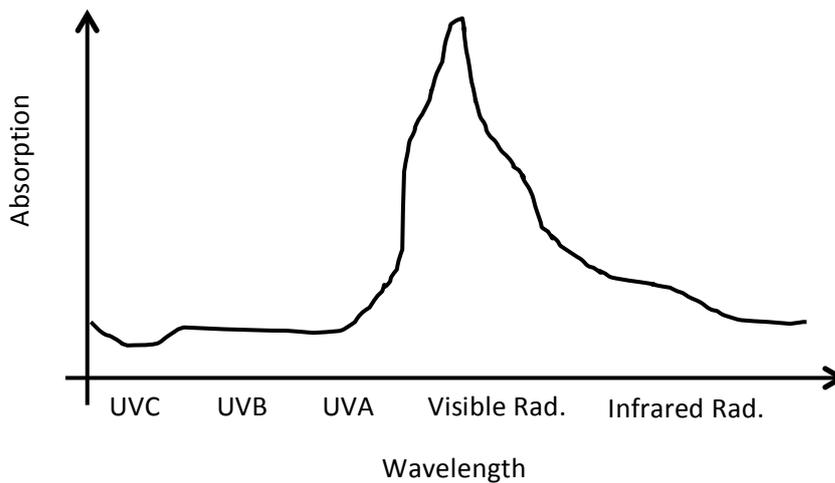
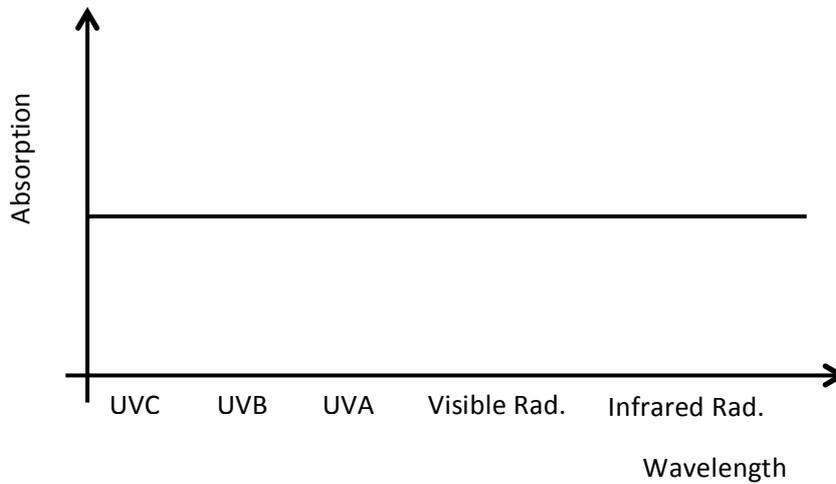
Source: [http://commons.wikimedia.org/wiki/File:World\\_map\\_blank\\_black\\_lines\\_4500px\\_monochrome.png](http://commons.wikimedia.org/wiki/File:World_map_blank_black_lines_4500px_monochrome.png), CC BY-SA 3.0.

6. Are UV light and vitamin D sufficient to explain the current world distribution of skin color?

7. How might you explain that Inuits, living at northern latitudes, are relatively dark-skinned (much more so than expected for their latitude)? Propose a hypothesis.

8. Conversely, Northern Europeans are slightly lighter-skinned than expected for their latitude. Propose a hypothesis to explain this observation.

Which of the following absorption spectrum might be the most appropriate for melanin?



**Site information:**

- Ultraviolet radiation (UVR) is extremely dangerous for humans.
- The visible and infrared radiation is less harmful than UVR.
- One of the most important acute effects of UVR is DNA photodamage. Ultraviolet A (UVA) and Ultraviolet B (UVB) show different properties regarding their biological effects on the skin. UVB radiation is more cytotoxic and mutagenic than UVA.
- UVB is 3-4 orders of magnitude more effective than UVA for DNA photodamage, erythema tanning and skin cancer.
- UVC is the most dangerous radiation and it is blocked by the ozone layer.