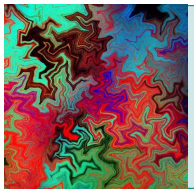

# Red Tattoo



## HOW TO USE THIS RESOURCE

The image for this resource, which shows tattoo ink particles inside cells, can serve as a phenomenon to explore the key concepts described below.

The pedagogical practice of using phenomena to provide a context for understanding science concepts and topics is an implementation practice supported by the Next Generation Science Standards (NGSS). Phenomena are observable occurrences that students can use to generate science questions for further investigation or to design solutions to problems that drive learning. In this way, phenomena connect learning with what is happening in the world while providing students with the opportunity to apply knowledge while they are building it.

The "Implementation Suggestions" and "Teaching Tips" sections provide options for incorporating the image into a curriculum or unit of study and can be modified to use as a standalone activity or to supplement an existing lesson. The student handout includes reproductions of the image and the "Background Information" section.

## KEY CONCEPTS

A. Skin consists of different layers, each composed of a community of cells. Some of these cells produce melanin, a pigment that gives skin color.
B. The amount and kind of melanin skin produces is genetically controlled, but it is also influenced by environmental factors such as sun exposure.

## NGSS PERFORMANCE EXPECTATIONS

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

## BACKGROUND INFORMATION

Tattoos are permanent designs made by inserting special pigments, such as tattoo inks, into a person's skin. Modern tattoo artists usually use machines with fine needles to inject tiny ink particles deep into the skin. The ink particles end up in the dermis, the layer of tissue beneath the outer layer of skin (epidermis). These particles typically stay in the dermis for life. A tattoo can be removed by using lasers to break down the particles.

The image shows a section of human skin with a red tattoo, magnified under a microscope. Dark red particles of tattoo ink, which can be seen in the top center of the image, are inside cells in the dermis. Cell nuclei appear as dark blue spots, and blood vessels appear as solid regions of bright pink. The epidermis is the dark purple region in the bottom-right corner of the image. The long stringy structures by the epidermis are keratin, the protein that makes skin waterproof.

### Technical Details:

A section of human skin with a tattoo was stained in purple and pink with hematoxylin and eosin. The skin was then photographed using a light microscope at 400x magnification.

## IMPLEMENTATION SUGGESTIONS

The following suggestions outline several options for incorporating the image into a unit of study as a phenomenon:

Engagement, establishing prior knowledge, and providing context:

- Begin the lesson by asking students to predict what would happen if they were to draw on their hands with pen or washable marker.
  - Most students will have had some experience with this already. You can also ask that students (voluntarily) draw a line on one of their hands with marker the class period before and observe what happens over the course of one to two days.
  - Students may predict that the marker or pen would fade over the course of hours or days, depending on the number of times they washed their hands, exposure to the environment, etc.
  - Students may begin to generate questions such as:
    - Why do some markers or pens take longer to fade than others?
    - Why do some markers or pens show different pigment colors as they fade?
    - What makes a tattoo, which is permanent, different from drawing on your hand?
  - If students don't begin to generate these types of questions, prompt them to do so before moving on to the next activity. In particular, ask them to consider the difference between pen or marker ink, which is temporary, and tattoos, which aren't. It may be helpful for students to discuss their experience or familiarity with tattoos before considering that as a question.
- Tell students that they will be looking at an image related to a tattoo, which shows where tattoo ink sits within layers of skin. Show students the image and ask them to make observations using the sentence stems "I notice …", "It reminds me of …", and "I wonder …"
  - It may be helpful to tell students that the "top" of the skin is in the lower right corner of the image, and that the skin has been stained so that cells are shown in pink or purple.
- Use a think-pair-share protocol to have students share their observations and questions about the image. Record class observations, noting when students make similar observations and drawing attention to the range of student-generated questions.
  - Students may observe that there appear to be different layers of the skin, which include different cell types; that different cell types have different shapes and densities; and that the tattoo ink sits within a deeper layer of the skin.
  - Students may ask why the tattoo ink has to sit in a specific layer of skin in order to be permanent, what different cell types do and why they're shaped differently, and if and how tattoo color differs from skin color.
- At this point, have students read the "Background Information" for the image. Transition to the next set of activities by saying that they will be exploring what forms skin and what skin's function is, with a particular focus on what determines skin color.

Exploration, assessment, and extension:

- Exploration/Investigation and Assessment:
  - Have students do the Interactive Exploration of *How We Get Our Skin Color* and accompanying worksheet. The worksheet includes the following components:
    - opportunities for students to generate questions (It may be helpful to have students consider the questions they've already generated to see if they want to revise, extend, or add to their questions.)
    - items examining the different layers of skin, the function of different cell types, the function of melanin, and how melanin relates to mutations and cancer
    - items pertaining to genes that determine skin color, with an emphasis on the *MC1R* gene
    - a concept map in the last item that serves as a formative assessment of students' understanding of skin color
  - Have students complete the "Zebrafish and Skin Color" activity, which elaborates on how genes control the number and composition of organelles called melanosomes, which determine skin color.

    - Have students watch the short film *The Biology of Skin Color* before doing this activity.
    - This activity asks students to examine a group of images, tables, and data displays in order to construct an explanation about the evolution of light skin color in some human populations. Students use zebrafish as a model for understanding how changes in the *SLC24A5* gene, which affects melanin production, can lead to changes in phenotype.
    - It may be helpful to jigsaw this activity by having "expert" groups of students examine different images and questions, and then asking the groups to share with one another. It may also be helpful to reduce the number of questions to focus on the intended learning outcomes for the course.
  - After students complete one or both of these activities, ask them to construct explanations for why tattoos are permanent and how tattoo ink differs from skin pigmentation. Their explanations should include a clear understanding of the structure of skin and what determines skin color.
- Extension:
  - The "Understanding Variation in Human Skin Color" activity has students explore the question of how many genes control skin color. Students consider the mathematical relationship between the number of genes and the number of phenotypes observed, as well as how to use the frequencies of alleles related to skin color to infer ancestry using SNPs.
    - It may be helpful to review that multiple genotypes can lead to the same phenotype.
    - Students will be asked to translate an observed pattern in the relationship between genotype number and phenotype number into a mathematical expression. Depending on students' math skills, it may be helpful to model how to do this or to modify the activity. For example, students could be given a number of expressions to select from and asked to support their selection with evidence.
    - It may also be helpful to modify this activity for length, particularly the narrative sections in Parts 2 and 3. For example, Part 2 can be jigsawed by having different students in a group (or various groups of students) read different sections of the text in order to answer different questions. Students can annotate the passage by underlining the answers to their question, then share with one another.
    - For Part 3, it is necessary to complete both Profiles 1 and 2. It may be helpful to divide this task among students or to have students highlight (in different colors for Profiles 1 and 2) the allele frequency for each person's SNPs. For the latter, consider making two copies of Table 2 so that students can highlight separately.

## TEACHING TIPS

- Present students with the image first, before they read the background information.
- Background information may be edited to support student proficiency, course sequence, etc.
- The image may be projected in lieu of handouts.
- Printed images can be laminated for use in multiple classes.

## RESOURCE-PAIRING SUGGESTIONS

Use these images to introduce a lesson on:

- the integumentary system
- evolution of traits in human populations

## SOURCE

Photo by Marianne Hamel, MD, PhD, Bethlehem, PA; Nikki Johnson, MFA, New York, NY (www.deathunderglass.com)

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