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101 Things Everyone Should Know About Science

“...encourages a lifetime of curiosity about the world around us!”

Ages 8-12, 8.5” x 5.5”, 160 pages; \$9.95



Science affects everything—yet so many of us wish we understood it better. Using an accessible question-and-answer format, *101 Things Everyone Should Know About Science* expands every reader’s knowledge. Key concepts in biology, chemistry, physics, earth, and general science are explored and demystified by an award-winning science writer and a seasoned educational trainer. Endorsed by science organizations and educators, this book is perfect for kids, grown-ups, and anyone interested in gaining a better understanding of how science impacts everyday life.

Sample Questions!

1. Name some characteristics of all mammals
2. Name three of the bodily fluids
3. What are the three states of water?
4. What mineral is found in a saline solution?
5. What do we use calories to measure?
6. What happens over time when iron is exposed to oxygen?
7. At the same pressure, which is more dense—hot air or cold air?
8. How does a semiconductor work?
9. Each year, Earth revolves once around what?
 - a) the sun
 - b) the moon
 - c) its axis
 - d) the Milky Way
10. What are the four major directions? In which direction does the needle of a compass point?

11. The continental divide separates:
 - a) which animals are nocturnal and which are diurnal.
 - b) the Northern Hemisphere from the Southern Hemisphere.
 - c) the direction water travels to the sea.
 - d) where it rains from where it snows.
12. Why is it colder an hour after sunrise than it is at sunrise itself?
13. What is a hypothesis?
14. What is the goal of a double-blind, placebo controlled study?
15. How can you use a lemon to light a light bulb?

Answers:

1. All mammals have backbones, are warm-blooded, have hair or fur, and drink their mother's milk when they are born. All mammals are vertebrates, which means they have backbones, unlike worms or insects. They are also able to maintain a constant body temperature, which is called being warm-blooded. Mammals have hair or fur at some point in their lives, and the females produce milk for their young through mammary glands. Mammals have large brains with modified skulls, complex teeth, and three ear bones. Their skulls have adapted over time to support their elaborate chewing muscles, and to better contain their large brains. Scientists believe that mammalian ear bones (the malleus, incus, and stapes) evolved from bones that were no longer needed, such as a bone to support gills. There are three orders of mammals: monotremes (egg-layers), marsupials (pouched mammals), and placentals (which account for the majority of mammals, including humans).

2. Blood, sweat, saliva (or spit), tears, breastmilk, semen, urine, mucus, lymph, plasma, serum, and digestive juices. The human body is composed mostly of water, which our body uses to produce different fluids. These fluids help the body to work properly. Glands are organs in the body that create and release chemical substances through ducts. Glands produce sweat, saliva, tears, and breastmilk. Blood comprises two fluids and it also carries hormones, nutrients, infection-fighting cells, and oxygen. Plasma is the liquid component in the blood, while serum is the protein-rich fluid that remains after blood clots. Lymph is a milky fluid that contains lymphocytes, a type of white blood cell. It plays a critical role in the body's immune system by filtering out and destroying toxins and germs. In mature males, the reproductive system produces semen, which contains the sperm needed to reproduce. Our kidneys process urine to carry wastes out of the body. Mucus is a thick secretion made by special tissues, including the inside of the nose and throat.

3. Liquid, solid, and gas.

Water exists in three states. We use the liquid state most often in our daily activities, for drinking, washing things, and cooking. Liquids do not hold a shape, but they maintain the same volume. In humans, liquid water makes up about 70 percent of our bodies. Ice, snow, and frost are frozen water. Water's freezing temperature—the highest temperature at which water will become solid—is 32°F (0°C). Water vapor is water in its gaseous state. Until it reappears as a liquid or solid, it is invisible. Water evaporates into the air from bodies of water and from plant and animal respiration. Water vapor is an important regulator of the earth's heat. Without it, and other so-called greenhouse gases, our planet would be very hot by day and very cold at night. A gas doesn't hold its shape or maintain its volume. For example, if you pour one liter of water from a watering can into a bucket, it's still one liter. If you take one liter of water vapor and release it into a two-liter bottle, it will spread out to fill the entire bottle. At sea level, water vaporizes at 212°F (100°C).

4. Salt.

Minerals (like salt) are natural compounds formed through geological processes. Saline is the term used to describe something, including a solution, that contains salt. The chemical name for salt is sodium chloride. Oceans are huge saline solutions, containing about 3.5 percent salt. Salt is also found in some rivers, lakes, and seas (e.g., the Dead Sea and Great Salt Lake). There are natural salt beds that are thought to have come from the salt water of evaporated ancient seas. Salt manufacturers obtain salt either from these beds or by evaporating seawater. People have used salt as a seasoning and to preserve food supplies since ancient times. It was even used as money, in the form of salt cakes, by the Hebrews and other societies during Biblical times. There are references in the Christian Bible to salt and its value (e.g., “any man worth his salt.”) In Roman times, salt was an important item of trade and was used as money as well. Roman soldiers received part of their pay in salt, and newborn babies were rubbed with salt to promote good health. To compare a person to the “salt of the earth” is to say that they are valuable and have worth. Before refrigeration, rubbing salt into meat was the only way to preserve it. Salt is an excellent cleaning agent, drives away ants, is an effective antiseptic, and is used in skin treatments. Solutions of salts in water are called electrolytes. Both electrolytes and molten salts conduct electricity. Electrolytes also help the kidneys retain proper fluid levels and help balance the amounts of acids and bases in our bodies. They also help the cells in our bodies maintain a proper “voltage” so that the nerve cells can communicate with each other via electrical signals. Electrolyte drinks containing sodium and potassium salts are used to replenish the body’s water and electrolyte levels after water loss. Excessive water loss, resulting in dehydration, can be caused by exercise, diarrhea, vomiting, starvation, or surgery.

5. Energy.

We use calories to measure heat or energy. Scientists define the small calorie, or gram calorie (c), as the amount of heat it takes to raise the temperature of one gram of water 1°C. The large calorie, or kilocalorie (C), is equal to 1,000 small calories and is used to measure the amount of energy produced by the food we eat. Some items we consume have no calories, like water, coffee, or artificially-sweetened drinks, and provide us with no energy—although coffee and some diet sodas contain caffeine, which can create the illusion of energy. Other foods, such as cake and doughnuts, have lots of calories, but they provide little energy since they are very low in nutrients. These are known as empty calories. Any extra calories we consume beyond what is needed for our daily activities are stored by the body as fat.

6. It rusts.

Rust is the common name for a very common compound, iron oxide. For iron (chemical symbol Fe) to become iron oxide, three things are required: iron, water, and oxygen. Iron oxide, (Fe_2O_3) is so common because iron readily combines with oxygen (so readily, in fact, that pure iron is only rarely found in nature). Iron or steel rusting is an example of corrosion, an electrochemical process. Water speeds the process because it allows for the formation of hydroxide (OH^-) ions. The rust that forms is much weaker than iron; when iron becomes severely rusted, it will crumble away. To prevent rusting (or the oxidation of iron), rustproof paint can be applied—a common occurrence on the Golden Gate Bridge in San Francisco. In other applications, nickel and chromium are added to iron to bind together the atoms and prevent them from rusting.

7. Cold air.

Cold air is more dense than warm air. Air is made up of nitrogen, oxygen, and other molecules that are moving around at incredible speeds, colliding with each other and all other objects. The higher the temperature is, the faster the molecules move. As the air is heated, the molecules speed up and push harder against their surroundings and each other. If the volume of the area is not fixed, this increases the space between the molecules, making the air less dense. For example, when the air in a hot-air balloon is heated, it expands (molecules speed up and spread apart). Now less dense than the surrounding air, the balloon rises. When the heater is turned off, the air in the balloon cools, the molecules slow down and move closer together, and the balloon descends.

8. By conducting electric impulses in a controlled fashion. Semiconductors have had a monumental impact on our society. You find semiconductors inside most microprocessor chips—the heart of any normal computer. Anything that’s computerized or uses radio waves depends on semiconductors. Semiconductors, often created with silicon, allow the transmission and control of electric impulses in microscopic circuits. The smallness of these circuits has led to portable technology that could not have been built with the previous technology of vacuum tubes. For example, the computing power of a modern laptop computer would have required a large building full of power-hungry equipment and a large maintenance staff were it not for semiconductor technology. A diode is the simplest possible semiconductor device, and is therefore an excellent beginning point if you want to understand how semiconductors work. A diode allows current to flow in one direction but not the other. You may have seen turnstiles at a stadium that let people go through in only one direction. A diode is a one-way turnstile for electrons. Most diodes are made from silicon. You can change the behavior of silicon and turn it into a conductor by mixing a small amount of an impurity into the silicon crystal. A minute amount of an impurity turns a silicon crystal into a viable, but not great, conductor—hence the name “semiconductor.”

9. Earth’s orbit around the sun is called Earth revolution. This celestial motion takes 365.26 days to complete one cycle. Earth’s orbit around the sun is not circular but elliptical. An elliptical orbit causes the distance from Earth to the sun to vary annually. Because Earth’s axis is tilted in relation to its orbit, the Northern Hemisphere receives longer and more direct exposure to the sun for half the year. For the other half, the Southern Hemisphere receives the warmer weather. The moon revolves around Earth much in the same way that Earth revolves around the sun, but it takes only 28 days for the moon’s revolution. Earth’s axis is the invisible line extending through its center from pole to pole. Earth spins, or rotates, on its axis one rotation every 24 hours, causing day and night. The Milky Way is the galaxy to which our solar system belongs.

10. The four major directions are north, south, east, and west; a compass needle points north. A compass, often used when hiking or sailing, is a navigational tool used to tell direction. Magnets in the compass align themselves along a magnetic north-south orientation, which causes the needle to align with the magnetic North Pole, so it points north. The compass card inside the glass has the four headings shown as N, E, S, and W (going clockwise) and subheadings of northeast, southeast, southwest, and northwest. Numbers appear every 30 degrees. Long vertical marks occur every 10 degrees, with intervening short marks at 5-degree points. The compass card containing the magnets is mounted on a small pivot point in the center of the card assembly. This allows the compass card to rotate and float freely. The enclosure of the compass is filled with white kerosene to provide a medium to dampen out vibrations and unwanted oscillations. A lubber line is etched onto the glass face of the instrument to enable exact reading of the compass. When a compass points north, it is pointing towards magnetic north, or in the direction of the earth’s magnetic field. True north, also known as geographical north, is the actual northernmost

point on the earth, or the center of the North Pole. The two measurements differ because the Earth's magnetic "north pole" is actually in Canada. In order for an explorer to determine his actual location, he has to know the difference between true north and magnetic north, which changes depending on the longitude.

11. The direction water travels to the sea.

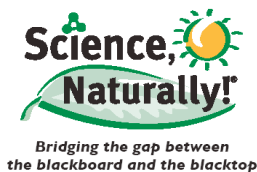
The North American continental divide is a mountain ridge that runs irregularly north and south through the Rocky Mountains and separates eastward-flowing from westward flowing waterways. The waters that flow eastward empty into the Gulf of Mexico by way of the Mississippi and other rivers. The waters that flow westward empty into the Pacific Ocean. Every continent with the exception of Antarctica has a continental divide. Some continents may have more than one. North America also has an eastern continental divide, which runs along the Appalachian Mountains. Rivers to the west of this divide drain into the Mississippi and other rivers that flow into the Gulf of Mexico. Waterways to the east of the divide flow into the Atlantic Ocean. Nocturnal and diurnal refers to the active time for an organism. An animal that is active during the day and rests at night is diurnal. An animal that primarily rests during the day and is active at night is nocturnal. The equator, an imaginary line drawn around the earth halfway between the north and south poles, separates the northern and southern hemispheres. Rain is liquid precipitation while snow is solid crystals. There are several factors that affect whether precipitation falls as snow or rain, such as temperature and elevation.

12. Because the planet continues losing heat after sunrise. We think the minimum temperature should occur at sunrise because the earth has been cooling down all night. The temperature drops throughout the night because of two processes. The earth no longer receives energy from the sun, and the earth radiates energy to space. Overnight, the balance is strongly negative, and the earth loses heat. At sunrise, solar energy again arrives, but the heat loss due to radiation to space dominates until about an hour after sunrise. At that time, incoming solar radiation increases enough to overcome the radiational heat loss.

13. A proposed explanation for why something happens. In common usage today, a hypothesis (which is Greek for assumption) is a provisional idea whose merit must be evaluated. Science happens in many ways. In some instances, a scientist observes a phenomenon—such as, food left at room temperature spoils more rapidly than food kept cool—and then develops a hypothesis for why. Other times, scientists set out to answer a question—such as, will mice be healthier if they eat vegetables or chocolate. Whether the hypothesis comes from an intellectual pursuit or an observation, the job of scientists is to perform tests in order to validate or negate their ideas. Through rigorous testing, scientists can help us learn what is speculation and what is real.

14. To eliminate the chance of bias. In a single-blind experiment, the individual subjects do not know whether they are so-called test subjects or members of an experimental control group, but the researchers do. In such an experiment, there is a risk that the subjects are influenced by interaction with the researchers. This is known as the experimenter effect. Double-blind describes an especially stringent way of conducting a scientific experiment. In a double-blind experiment, neither the individuals nor the scientists know who belongs to the control group. Only after all the data is recorded (and in some cases, analyzed) are scientists permitted to learn which individuals are which. Performing an experiment in double-blind fashion is a way to lessen the influence of prejudice and unintentional cues on the results. Strictly speaking, in this type of experiment, every scientist who interacts with or treats a subject should be "blinded." This doesn't mean that they are really sight-impaired, it means they don't know who is receiving a particular test or intervention.

16. **Turn the lemon into a battery.** A lemon can be used like a battery by placing a copper penny and a steel paper clip (or a zinc-coated nail) into slits cut into the lemon skin, then connecting the penny and clip with a small piece of wire. The two different metals react with the acid in the lemon juice and cause electrons to travel from the negative terminal (the steel or zinc) to the positive terminal (the penny). An electric potential is created when the different metals are immersed in the lemon, and you can measure this with a voltmeter. One lemon alone will probably not produce enough power to light a bulb, but if you link four or more lemons together in a circuit by connecting the negative terminal of one lemon to the positive terminal of the next, and so on, you may get enough electricity to light an LED bulb, or some other small device.



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