1-10 to 13

Minerals in Medicine

On loan from the Smithsonian Institution National Museum of Natural History

Minerals and metals are not only interesting to look at and to study in geology class, they are essential elements and components required for human biology. They are also critical for many of the technologies that define our modern medical world and are key to today's biomedical enterprise. They are used as sources or components of drugs and devices and they are key to innovative technologies. The items in this display are some examples of crystals and minerals critical to keeping ourselves and our bodies healthy and normally functioning and are also key in past, present and new technologies.

For example, look at copper. Not only is it found in MRI scanners, it also kills bacteria, viruses, and fungi on contact. For this reason, some hospitals utilize copper or copper alloys for critical surfaces like door handles, bed rails, and chair armrests. Another mineral with significant medical benefits is silver, an active ingredient in some topical antibiotics, wound dressings, and medical devices. Silver prevents bacterial growth and promotes healing. A small amount of silver makes *E. coli* bacteria significantly more sensitive to commonly prescribed antibiotics like penicillin. The metal titanium is a critical component in artificial joints because it is strong and light and works well as a substitute for bone.

Have you ever heard the phrase "a heart of gold"? Thanks to modern medicine and the unique physical properties of gold, this phrase can actually be taken much more literally. Doctors began using gold to improve circulation and prevent infection during the late 1800s. It has also been used as treatment for rheumatoid arthritis and other autoimmune disorders. Currently, gold nanoparticles are being used in cancer studies around the world. Gold is used to make many state-of-the-art medical technologies. Because of its unique molecular makeup, gold is virtually impervious to corrosion, acid, and bacterial growth making it a valuable metal for heart treatment technologies. Gold is also malleable while being nearly indestructible, which makes it an ideal coating for instruments such as pacemakers and heart stents. In some cases, gold-plated pacemakers have saved the lives of patients after pacemakers constructed of other materials caused allergic reactions or infections.

As headlines about lead and mercury poisoning attest, exposure to too much metal can be harmful. But not getting enough of certain metallic compounds in the right places can make us sick, too. This is the case with conditions such as iron-deficiency anemia and osteoporosis. The National Institutes of Health has funded research into metals that affect human health. Two examples are zinc and copper.

Zinc Imbalance: Small amounts of zinc help ensure a proper immune response and healthy nervous system. Zinc also regulates the function of some genes, enables many proteins to carry out their vital roles, and helps speed the chemical reactions that keep us alive. On the flip side, an imbalance of zinc has been linked to Alzheimer's disease, diabetes, prostate cancer and seizures. Chemist Stephen Lippard of the Massachusetts Institute of Technology discovered with colleagues that zinc helps regulate communication between two types of brain cells in the hippocampus, the brain's center of learning and memory. Their findings suggest that zinc affects how we form memories and that high concentrations may contribute to epilepsy, where abnormal cell communication causes seizures. Scientists had seen zinc in specific hippocampal cells before but weren't sure of why or its significance.

Chaperoning Copper: Our bodies try to ensure that metals go only where they need to and in exactly the right amount. Like teachers keeping an eye on students at the prom, so-called "copper

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chaperone" proteins protect cells from unwanted interactions with copper and safely deliver copper atoms to their proper intracellular destinations.

Malfunction of other copper transporters can lead to abnormal brain development, weak limbs and bones, seizures and kinky, brittle hair. That's what happens in children with Menkes disease, who show signs of severe copper deficiency, which can be improved by copper injections. Conversely, when copper removal from our bodies is blocked, the metal can accumulate in the liver and parts of the brain and cause a different disorder, Wilson's disease. Copper chaperones and transporters that also ferry platinum can affect how cancer patients respond to cisplatin, a platinum-containing substance used in drugs to treat advanced testicular and ovarian cancers.

One way researchers are studying these copper-related disorders is by looking at the three-dimensional shapes of the copper chaperones and transporters. Researchers at Northwestern University and the University of Liverpool deciphered the intricate structure of a chaperone protein that inserts a molecule of copper into an enzyme whose defective forms have been linked to some inherited types of amyotrophic lateral sclerosis, also known as Lou Gehrig's disease. This structural knowledge, which offers insight into how the chaperone works and interacts with other molecules, deepens scientists' understanding of the disease and could provide a potential new treatment target.

Without minerals like the ones in this exhibit our health would be in jeopardy, development of new medical technologies could be limited and lifesaving medications could not be formulated.

CAN YOU MATCH THE MINERALS AND METALS WITH WHAT THEY DO IN OUR BODIES?

A: Manganese	B: Iron	C: Calcium
D: Magnesium	E: Zinc	F: Copper

_____ 1. The most abundant element in our bodies, stored in bones and teeth. Critical for proper muscle and nerve function, hormone release and more. Found in dairy products, broccoli, figs and sardines.

_____ 2. Found in pennies, MRI scanners and the Statue of Liberty's skin, this metal is also needed for firm skin, cartilage and ligaments. It has been used to disinfect wounds and treat infections. Food sources include beef liver, lobster, shiitake mushrooms, chocolate and nuts.

_____ 3. This metal is found in red blood cells, where it is responsible for carrying oxygen to our tissues. It is abundant in red meat, beans and spinach.

_____ 4. This metal is used throughout our bodies in many ways, including immune function, brain activity, and growth and development. It can reduce the impact of age related macular degeneration. To get lots of it, eat oysters, fortified cereal, baked beans or beef.

_____ 5. Needed for normal functioning of cells, muscles, nerves, bones, a strong immune system and a steady heart rhythm. Abundant in whole grains, spinach and pumpkin seeds.

_____ 6. Stored mainly in the liver and kidneys, this metal helps our bodies make DNA and RNA, break down food into energy and heal wounds. Good sources are oat bran, other whole grains, pineapple and chickpeas

Answers: 1.C, 2.F, 3.B, 4.E, 5.D, 6.A

The following websites provide more information on minerals and their uses:

- Smithsonian Institution (http://mineralsciences.si.edu/)
- National Library of Medicine (https://www.nlm.nih.gov/medlineplus/minerals.html)
- Minerals Education Coalition (http://www.mineraleducationcoalition.org/pdfs/mineraluses.pdf)
- Science Views (http://scienceviews.com/geology/minerals.html)

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