frontiers for Young Minds

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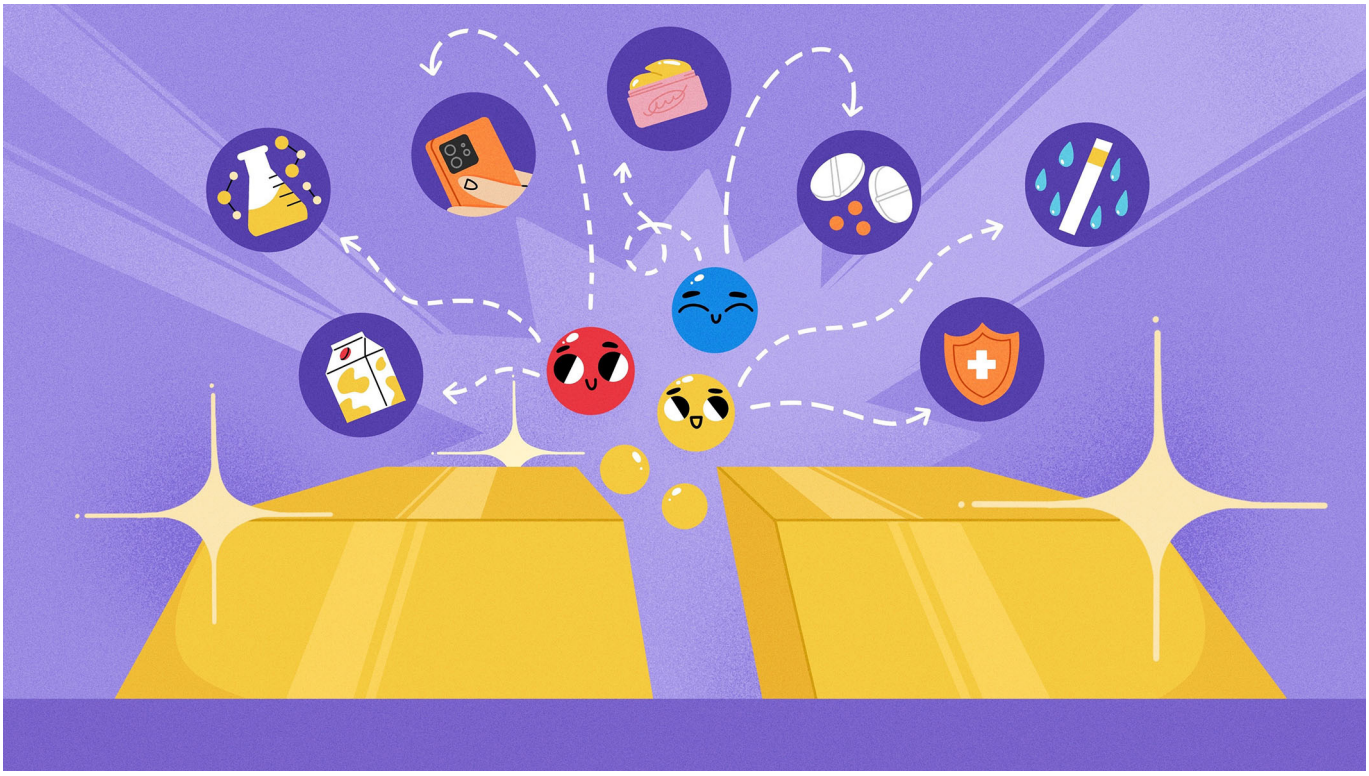

EVEN TINY OBJECTS CAN MAKE A BIG DIFFERENCE: THE STORY OF GOLD NANOPARTICLES

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YOUNG REVIEWERS:

ALI
AGE: 14

ELENA
AGE: 15

HASAN
AGE: 13

JAVIER
AGE: 8

JOSÉ
AGE: 14

SAMAR
AGE: 8

Did you know that some of the tiniest things can do the biggest jobs? In this article, we dive into the microscopic world of gold nanoparticles—extremely small bits of gold that you cannot see with just your eyes but are powerful enough to change the world! Imagine something so small that if an orange was as big as the Earth, these particles would still be hard to see. Gold nanoparticles can be used in medicine, electronics, and even for protecting our environment. You will learn how these tiny gold particles help doctors target diseases, make electronic devices work better, and keep our air and water clean. They also make cosmetics and food packaging safer and more effective. So, let us start our adventure into the tiny, exciting world of gold nanoparticles and discover how they make big impacts in many parts of our lives!

DO YOU KNOW WHAT "NANO" MEANS?

Is it hard to imagine that one tiny speck of material, so small you cannot see it with your eyes, can change the world? Well, gold can! In this article, we will explore the fantastic world of gold nanoparticles (GNPs), and you will learn what they are and how they are used in our daily lives. But first, do you know what "nano" means?

"Nano" means extremely small. How small, you ask? Imagine something so small that if an orange was as big as the Earth, nanoparticles would still be hard to see. That is how tiny nano things are!

If you would rather think in terms of numbers, something that is nano-sized is about 100,000 times smaller than the width of a single hair on your head. Playing with nano-sized objects is like playing with the tiniest Legos. When you build with these microscopic pieces, you can create things that have never been made before. This exciting kind of building is called working in the nanoscale.

So, why do scientists study GNPs? These super tiny objects have some amazing and unique properties. Because GNPs are so small, more of their atoms are exposed on the surface rather than hidden inside, so they can interact more easily with the world around them. GNPs can do things big objects cannot. For example, they help us make brand new types of batteries and solar cells that are better than ever before. GNPs are one of the coolest and most important tiny things in the world of nano.

HISTORY OF GOLD NANOPARTICLES

People have been using GNPs for a very long time, even if they did not know it. A long time ago, a special cup called the Lycurgus cup could change colors because it contained tiny bits of gold and silver (Figure 1). The beautiful colors in stained glass windows from old churches were also made with GNPs. In 1957, Michael Faraday first discovered that GNPs can interact with light in unusual ways when he synthesized very small particles of gold suspended in liquid. As nanotechnology developed in the 1980s, GNPs gained attention, leading to significant advances in their uses. Research on GNPs began in the early 21st century, leading to many uses that we will discuss later in this article. Over the centuries, GNPs have played a key role in advancing human knowledge, and research continues to expand their potential uses across multiple industries [1].

Figure 1

The Lycurgus Cup looks green when light shines onto it and bounces back to your eyes. It looks red when light passes through the glass. This color change happens because tiny gold and silver nanoparticles are mixed into the glass. These particles interact with light in different ways depending on how the cup is lit.

REGULAR GOLD VS. GOLD NANOPARTICLES

Regular gold, like the gold used in jewelry, is a shiny yellow metal that is very heavy and melts at a very high temperature. It is great at conducting electricity and does not easily react with other chemicals, which means it does not rust or tarnish. There is no liquid that can dissolve it except aqua regia, a solution of nitric and hydrochloric acids. For centuries, regular gold has been highly valued and widely used in a wide range of industries because of these properties. Its luster, rarity, and corrosion resistance make it a popular choice for jewelry and decorations. Gold's excellent electrical conductivity and resistance to rusting make it ideal for connectors, switches, and other electronic components. In addition, people and governments also value gold because it can be saved as wealth and used to support national financial reserves.

GNPs have some super cool properties that make them valuable in a wide range of applications, including various scientific and technological fields [2]. The ability of GNPs to conduct electricity makes them useful for creating tiny electronic components for many devices, such as iPads, cell phones, and computers. Also, the color-changing ability of gold nanoparticles is a great indicator that allows researchers to track reactions and changes. GNPs interact with light *via* **surface plasmon resonance**, which means that when gold is in its nanoparticle size, it can appear red, purple, or even blue, depending on the size of the particles, as shown in Figure 2. Finally, GNPs can speed up some chemical reactions, which makes them useful in things like fuel cells that need to remove carbon monoxide.

SURFACE PLASMON RESONANCE (SPR)

A scientific method that uses light to observe how tiny particles (like molecules) stick to each other, and it shows these interactions as they happen in real time.

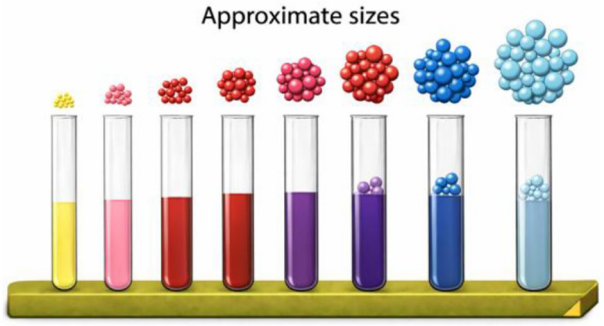

Figure 2

Gold nanoparticles can make liquids appear different colors depending on their size. Very tiny particles interact with light differently than larger particles, so the liquid may look red, purple, blue, or another color. Scientists can use these color changes as clues. If the color of a nanoparticle solution changes during an experiment, it may show that the particles have grown, clumped together, or reacted with another substance.

HOW ARE GOLD NANOPARTICLES PREPARED?

It is quite simple to create GNPs. They can be made by physical, biological, and chemical methods. Physical methods include laser ablation, which is when a very strong laser beam hits a piece of gold that is sitting in a liquid. The laser breaks off tiny bits of gold, which become GNPs. In terms of biological methods, scientists can use plants, bacteria, or algae to change a gold salt (chemical compounds that contain gold atoms mixed with other elements) into tiny bits of gold. One of the simplest ways to make GNPs is by a chemical method, in which a substance changes dissolved gold into tiny gold particles under controlled conditions.

CONTRAST AGENTS

substances that can improve image quality—in various medical imaging techniques.

COMPUTED TOMOGRAPHY

An X-ray imaging method that produces detailed images of the body.

MAGNETIC RESONANCE IMAGING

A medical imaging technology that produces precise images of the body's organs and tissues using a magnetic field and computer-generated radio waves.

GOLD NANOPARTICLES IN OUR LIVES

In addition to the uses we have already described, we will now explore more of the amazing applications of GNPs in nanotechnology (Figure 3):

Diagnostics and Drug Delivery

GNPs do amazing things in medicine. They help doctors quickly find and diagnose serious illnesses like cancer and heart disease. They can also make treatments better by sending medicines right where they are needed in the body, which helps get rid of the sick parts without harming the healthy ones [2]. For example, gold nanoparticles are being explored for cancer treatment, where they can be used to deliver the treatment directly to the tumor while leaving healthy cells unharmed [3]. GNPs also serve as **contrast agents**—substances that can improve image quality—in various medical imaging techniques, such as **computed tomography** and **magnetic resonance imaging**. GNPs therefore enable early and accurate detection of diseases. They can also make some other medical tests better at finding tiny clues of disease. The fact that gold does not interact with most compounds

Figure 3

The many uses of GNPs.

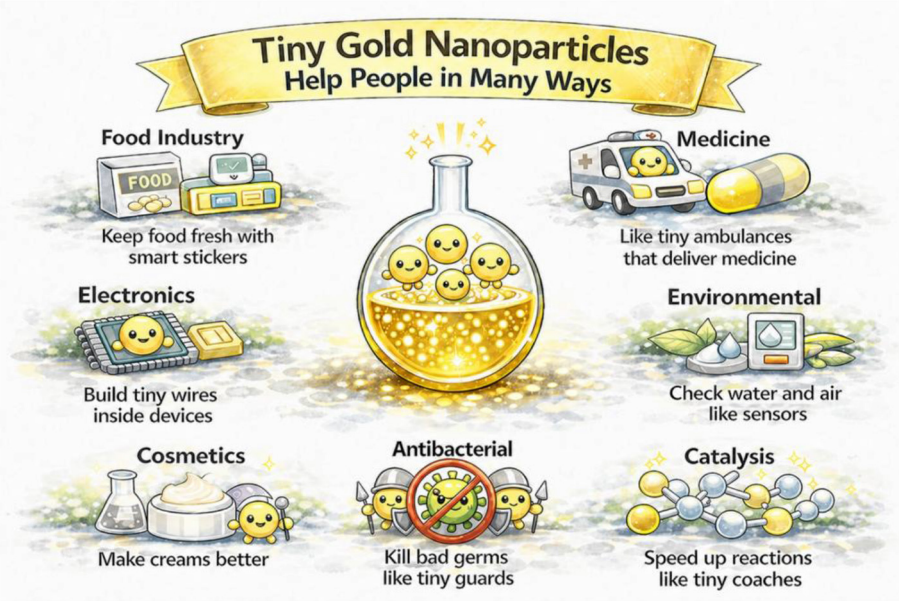

Figure 3

makes it non-toxic to the body, giving it huge potential for medical uses like dental fillings.

Environmental Protection

GNPs can help make the environment safer for humans and wildlife, too! Scientists do this by building gold into test strips, filters, or sensors, where the gold acts as a warning signal or a cleaner. for cleaning up wastewater and polluted air. When harmful contaminants from the environment interact with GNPs, the GNPs can change color. This color change tells scientists pollution is present. Because GNPs are so small, they have a lot of surface area for other molecules to stick to. This can help them capture some pollutants, so scientists are exploring their use in water treatment and oil-spill cleanup.

Electronics

GNPs are also super helpers in electronics, keeping us entertained and connected to the world. They are really good at conducting electricity, which makes devices like computers and smartphones work faster and better**.** To use GNPs in electronics, they are mixed with or used to coat weaker conductors like copper, nickel, iron, or even carbon materials. This can lead to better-performing gadgets that are more energy efficient [2].

REACTIVE OXYGEN SPECIES

Unstable, oxygen-containing chemical molecules and free radicals that easily react with other molecules inside cells.

Cosmetics

GNPs are even in beauty products! They help heal skin wounds and are added to creams that make skin look younger and reduce swelling. Factors like sun and cigarette smoke can damage the skin and lead to the production of dangerous substances called **reactive oxygen species** (ROS). Too much ROS damages cells, DNA, and proteins,

leading to skin aging. GNPs may counteract the effects of ROS, so, when added to cosmetics, they might help protect the skin.

Food Industry

Similar to how GNPs are used to detect pollution in the environment, researchers have used their color-changing ability to detect harmful chemicals in milk. GNPs are also frequently used in food packaging and as food storage solutions to help keep foods fresh and safe, by quickly detecting any mold or contamination [4].

Anti-Bacterial Products

GNPs can fight bacteria, which makes them useful in everyday items like cutting boards, where they help reduce germs. Scientists can make GNPs work even better by changing their size or mixing them with other materials, and they can also be used to create antibacterial medicines.

Speeding Up Chemical Reactions

GNPs are great helpers in chemistry. They speed up reactions without getting used up, which is especially useful for making certain chemicals and other products faster and more sustainably in factories. **Green chemistry** is concerned with protecting the environment. By using GNPs to speed up reactions, the reactions can often happen in a more environmentally friendly way—using less energy and fewer harmful chemicals.

GREEN CHEMISTRY

The science of designing chemicals and processes so they are safe produce little or no harmful substances, and prevent pollution.

WHAT HAVE YOU LEARNED?

In this article, you have learned how tiny gold particles, called GNPs, are super useful in many parts of our lives. They help doctors treat diseases, keep our environment clean, make electronics better, beautify skin care products, keep food safe, and even kill germs. Scientists want to make them safer, smarter, and more useful by improving their shapes and combining them with other materials. In the future, this could help create even better tools for health, energy, and the environment.

AI TOOL STATEMENT

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REFERENCES

1. Tomar, A., and Garg, G. 2013. Short review on application of gold nanoparticles. *Glob. J. Pharmacol*. 7:34–8. doi: 10.5829/idosi.gjp.2013.7.1.66173
2. Ghosh, P., Han, G., De, M. Kim, C. K., and Rotello, V. M. 2008. Gold nanoparticles in delivery applications, *Adv. Drug Deliv. Rev.* 60:1307–15. doi: 10.1016/j.addr.2008.03.016
3. Singh, P., Pandit, S., Mokkapati, V. R. S. S., Garg, A., Ravikumar, V., and Mijakovic, I. 2018. Gold nanoparticles in diagnostics and therapeutics for human cancer. *Int. J. Mol. Sci*. 19:1979. doi: 10.3390/ijms19071979
4. Hua, Z., Yu, T., Liu, D., and Xianyu, Y. 2021. Recent advances in gold nanoparticles-based biosensors for food safety detection. Biosens. Bioelectron. 179:113076. doi: 10.1016/j.bios.2021.113076

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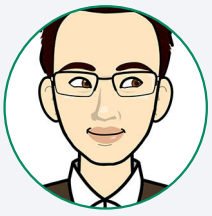
YOUNG REVIEWERS



ALI, AGE: 14

I am Ali, I am 14 years old, and I like playing video games and having fun with my friends and family. I am deeply interested in Science and Engineering, and I plan to pursue a doctorate in Chemical Engineering as my career inspiration and then teach

kids through much simpler ways, may be through new innovations and tools and may be only using video games to do math and science.

ELENA, AGE: 15
My name is Elena. I love learning about biology, anatomy and medicine. My hobbies and favorite things to do include reading, making jewelry and rowing. I have competed at 2 National Championships and Head of the Charles Regatta, placing top 5. It is a great sport to combine scientific and critical thinking with athletics. My favorite classes are Biology and Anatomy and Physiology. In Anatomy, we learn about the organ systems and are even drawing a diagram of the human body by hand to express how the organs function together. I hope one day to work in the medical field and do medical research to contribute to my community.

HASAN, AGE: 13
My name is Hasan. I enjoy learning about science and how things work. I love to play basketball and hang out with my friends. I hope to one day be a scientist and find solutions to many of our day-to-day problems. I love figuring out ways to help others. Science makes me feel it is possible to find answers to all our questions.

JAVIER, AGE: 8
I am studying 3° course of primary school and I would like to be a football player in the future. I like Maths, playing Lego plays, playing football and Nintendo games.

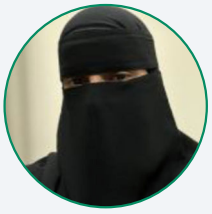
JOSÉ, AGE: 14
I am studying 4° course of secondary school and I would like to be an architect in the future. I like role plays, playing Minecraft and cycling.

SAMAR, AGE: 8
I am Samar, and I like playing with my friends and making friendship clubs. I am the president of a friendship forever club at my elementary school. I love going to my school library and looking at books. On weekends I always push my mom to take me to our neighborhood libraries as for me it is fun to just look at pictures in nice books about sea creatures and oceans. I am fascinated by living systems, particularly how life came into being in oceans and researching on Sharks and Whales. I love asking lots of questions to my teachers and parents. I also love Disney world and hope to continue visiting it every year, its lot of fun and inspires me to dream.

AUTHORS

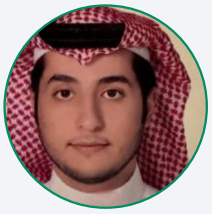
JOUD ALSAADOUN

I hold a master's degree in nanotechnology and nanomedicine from Alfaisal University in KSA. I am a researcher of petrochemicals at King Abdulaziz City for Science and Technology. My research is about how small particles, including nanomaterials, behave in the environment.



SAMAR ALDWEESH

Samar Aldweesh is a dedicated chemist at KACST in the petrochemical department. Her work also focuses on advanced materials, particularly gold nanoparticles and metal-organic frameworks (MOFs), pushing the boundaries of innovation in these areas.



SULTAN ALHOSHAN

My name is Sultan Alhoshan, and I am a researcher at King Abdulaziz City for Science and Technology. I love working on the synthesis of nanoparticles, especially silver and gold, and applying them to different applications.

MARWAN M. ABDULJAWAD

I am a chemical engineer, researcher, and leader at King Abdulaziz City for Science and Technology (KACST). I earned my PhD and master's degree in chemical engineering from the University of Arizona, where I also studied materials science and engineering. I enjoy exploring how tiny materials, such as nanoparticles, can be used to solve real-world problems in areas like the environment, medicine, and industry. I currently serve as General Manager of the General Department for Sustainability and Director of the Center of Excellence for Petrochemicals at KACST. I believe science becomes even more exciting when we can explain complex ideas simply, and I enjoy helping young people see how science can be used to make the world better. *mabduljawad@kacst.gov.sa