Insects as inspiration for scientific inventions

Insects have inspired numerous scientific inventions across various fields, from materials science to robotics and more. Their unique biological adaptations, such as their exoskeletons, flight mechanisms, and sensory systems, serve as blueprints for designing innovative technologies.

Materials Science

Insects produce remarkable materials that inspire synthetic alternatives.

- Chitin, the strong and lightweight exoskeletons of insects have inspired the development of new composite materials with enhanced strength and durability.
- The intricate structure of insect cuticles, with their helicoidal arrangement of nanofibers, has also influenced the design of advanced materials with gradient properties.
- Silk from silkworms and other insects while being used directly has also inspired production of synthetic silk. The green lacewing (*Mallada signata*), spins silk of remarkable tensile strength to suspend its eggs. Thomas Scheibel and Felix Bauer at the University of Bayreuth in Germany developed a synthetic protein based on a repeating amino-acid pattern found in one of the proteins in lacewing silk.
- Beetle shells: Strong, lightweight elytra (wing covers) inform biocomposites and armour design. Research studies have shown that bio-based fillers, like those found in beetle shells, can be used in developing high-performance composite materials suitable for various engineering applications.

Robotics

Insect-inspired robots, or "entobots," are being developed to mimic the agility, manoeuvrability, and sensory capabilities of insects. These robots can be used for tasks like searching disaster zones, monitoring environments, or even delivering small packages.

- Dragonflies and hoverflies inspired the design of micro aerial vehicles (MAVs) with stability and hovering capabilities.
- The DelFly, a Dutch insect-like drone, mimics insect flight.
- Robotic Insects (Spybots) like the Robobee by Harvard is a tiny flying robot based on bees.
- Defence Advanced Research Projects Agency project is developing many insect-sized applications. Insect cyborgs are real insects like beetles or moths fitted with microchips for surveillance.
- Jumping Robots are modelled after the locust's powerful hind legs and elastic storage.

Optics and Photonics

- The compound eyes of insects, with their many individual lenses, have inspired the development of novel camera systems and optical sensors.
- The unique way insects avoid reflection, as seen in glass-winged butterflies, has also led to advancements in low-reflective materials for solar cells and other optical devices.

- The structural coloration (not pigment-based) of butterflies like Morpho sp. Have inspired nanostructured materials, anti-counterfeit tech, and colour-changing fabrics.
- Beetle iridescence principle has been used in biomimetic paint, reflective clothing, and solar panels.

Navigation and Sensing

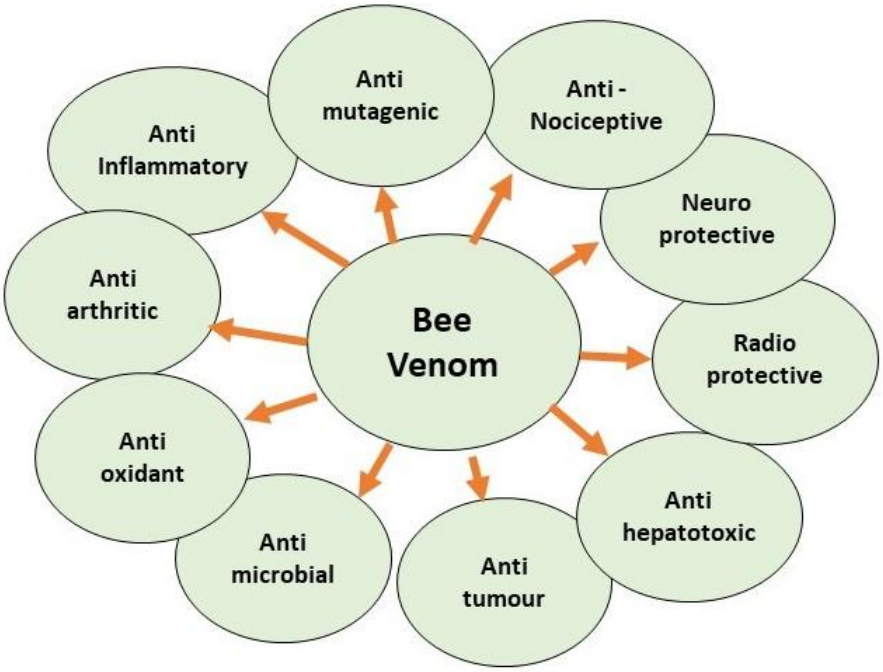
Insects possess sophisticated navigation systems

- The dung-rolling beetles using celestial objects for guidance, which have inspired the development of new GPS technologies.
- Studies of insect sensory systems, like those used by moths and mantids to detect bats, have led to advancements in radar and sonar technologies.

Medicine and Pharmaceuticals

Some insects contain compounds with medicinal properties

- Originating from Chinese traditional medicine, beetle toxins (Cantharidin from blister beetles) are used in wart treatment and cancer research.



- Hymenopteran venoms have a defensive substance that contains many biologically active compounds that have known pharmacological properties. Bee and wasp venoms. Bee venom contains many enzymes and peptides that are effective against various diseases. Bee venom has been studied for its anti-inflammatory and antimicrobial properties specially to treat rheumatoid arthritis, Parkinson's, and HIV.
- Silkworm enzymes (**serrapeptase**) have been used in pharmacology.

- Insect-derived antimicrobial peptides from blowflies, soldier flies, and moths are considered alternatives to antibiotics.

Architecture and Construction

The energy-efficient and sustainable designs of insect nests and structures have inspired the development of new architectural designs and building materials. Termite nests maintain stable temperatures using natural convection and humidity control.

The Eastgate shopping centre and office block in central Harare, Zimbabwe, designed by Mick Pearce is an energy-efficient building with minimal air-conditioning based on passive cooling principles of a termite mound.

Beehive structures: Inspire modular design, honeycomb geometry used in aerospace and construction materials.

Source; national geographic : https://www.youtube.com/watch?v=620omdSZzBs&t=25s

Lear more at https://www.bbcearth.com/news/what-termites-can-teach-architects

Insect Cell Lines

Insect cell lines, particularly those derived from moth caterpillars like *Spodoptera frugiperda* (Sf9, Sf21) and *Trichoplusia ni* (High Five™), are valuable tools in vaccine development. These cells, when used in conjunction with the baculovirus expression vector system (BEVS), can efficiently produce recombinant proteins, including viral antigens, for use in vaccines.