v) Biomimetic Prosthetics :- Prosthetics limbs have been designed to mimic the movement and function of natural limbs more closely. Advanced materials and control systems inspired by biological systems allow for better mobility and dexterity, improving the quality of life for amputees

Nature inspired material and mechanisms :-

1) Lotus Effect, which has inspired innovations in self-cleaning surface :-

Lotus Effect :-

Inspiration :- The lotus leaf has a unique microstructure that repels water and dirt, keeping it clean despite growing in muddy environments. This phenomenon is due to the combination of a superhydrophobic surface and a self-cleaning mechanism.

Application : Engineers and material scientists have replicated (or mimic) (to copy, often) the lotus effect to develop self-cleaning coating for various surfaces, such as glass, ceramics and metals.

Case Study : Self-cleaning Glass :

Problem : Glass surface, such as windows, often accumulate dirt, water spots and grime

② requiring frequent cleaning, especially in urban environments.

[Grime → means a thick layer of dirt]

Solution :- Inspired by the lotus leaf, researchers developed self-cleaning glass coating that mimic its superhydrophobic surface. These coating contain nanostructures that create a rough surface, causing water droplets to bead up and roll off, carrying dirt and contaminants with them.

Benefits :-

1.) Reduced Maintenance :- self cleaning glass ~~coating~~ requires less frequent cleaning, saving time, effort, and resources for building owners and maintenance crews.

2.) Improved Aesthetics (attractive) :- Buildings with self-cleaning glass maintain a cleaner appearance for longer periods, enhancing their visual appeal and property value.

3.) Environmental impact :- By reducing the need for cleaning agents and water, self-cleaning glass coating contribute to environmental sustainability (ability to maintain) by minimizing chemical runoff and water consumption.

Implementation :- Self-cleaning glass coating have been applied in architectural projects worldwide, including commercial

building, residential homes and public infrastructure. They offer a practical solution for maintaining clean and visually appealing (attractive) glass surface in various urban and industrial settings.

Overall, the Lotus Effect serves as a remarkable example of how nature's design principles can inspire innovative technologies that address real world challenges.

2) Self healing bioconcrete :-

Self healing bioconcrete is a remarkable innovation that draws inspiration from biological systems to address (rectification or deal with) the problem of concrete degradation.

Problem :- Concrete structures are susceptible (easily influenced) to cracks due to factors like shrinkage, temperature, fluctuations and external forces. These cracks allow water and harmful substance to penetrate, leading to corrosion of reinforcing steel and structural deterioration.

Solution :- Researchers at Delft University of Technology in the Netherlands developed Self-healing bioconcrete to address this issue. They incorporate (include) bacteria

④ and nutrients into the ~~cont~~ concrete mix to enable autonomous crack repair.
सक्षम बनाना (to make it possible)

Technology overview

i) **Bacteria :-** The main component of self healing bioconcrete is a specific type of bacteria called Bacillus spp., which remains dormant (not active for some time) within concrete until cracks form.

ii) **Nutrients :-** Calcium lactate serves as the nutrient source for the bacteria, providing the necessary energy for metabolic activity and mineral precipitation.

iii) **Activation :-** When cracks develop in the concrete, water enters and activates the bacteria. The bacteria consume the calcium lactate, producing calcium carbonate as a by product.

(iv) ~~The~~ **Healing :-** The calcium carbonate fills the cracks, effectively sealing them and preventing further ingress (entering) of water and harmful agents.

Benefits :-

i) **Longevity** (long life) :- self healing bioconcrete extends the service life of concrete structures.

ii) **Sustainability** (Ability to maintain) :- The self-healing process is environmentally friendly, as it utilizes naturally occurring bacteria and nutrients. It reduces the need for frequents repairs and the consumption of additional materials.

iii) **Cost-Effectiveness** (profit) :- while initially more expensive than traditional concrete, the long term saving achieved through reduced maintenance and repair.

Implementation :-

i) **Lab Testing** :- The effectiveness of self-healing bioconcrete was demonstrated through extensive laboratory testing.

ii) **Field Trials** :- Real world trials were conducted to validate the technology's performance in practical applications, including bridges, tunnels and other infrastructure projects.

iii) **Commercialization** :- self-healing bioconcrete has been commercialized by companies such as Basilisk and Blue Planet.

⑥ Conclusion :-

Self - healing bioconcrete represents a significant advancement in sustainable construction materials, offering a proactive solution to concrete degradation and structural maintenance.

Innovative technology enhances the durability, resilience and longevity of concrete structures.