BIOLOGY FOR ENGINEERS 21BE45

SCHEME & SOLUTION IAT#3

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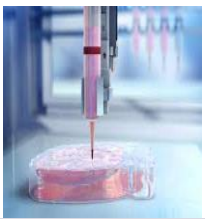
1.	 • Shark skin refers to the unique and specialized scales similar to teeth, called Dermal Denticles. • The denticles play an important part in swimming efficiency. • The teeth and skin also help protect the shark from injuries and several elements in the water. • **Characteristics and Advantages** of Shark Skin: • Reduced drag: The denticles have a sleek hydrodynamic shape, which helps reduce drag as the shark swims through water. • Improved manoeuvrability: The structure of the denticles contribute to enhanced manoeuvrability. • Protection: The tough, overlapping nature of the dermal denticles provides a protective layer for sharks • Anti-fouling properties: Shark skin has been observed to possess anti-fouling properties • Bacterio static properties: inhibit the growth of certain bacteria, which may be useful in preventing infections. • Camouflage and counter-shading: Some shark species have specific patterns and coloration on their skin that serve as camouflage or counter-shading, aiding in their hunting strategies and protection from predators. Protection: The tough, overlapping nature of the dermal denticles provides a protective layer for sharks • Anti-fouling properties: Shark skin has been observed to possess anti-fouling properties • Bacteriostatic properties: inhibit the growth of certain bacteria, which may be useful in preventing infections. • Camouflage and counter-shading: Some shark species have specific patterns and coloration on their skin that serve as camouflage or counter-shading, aiding in their hunting strategies and protection from predators. Shark skin has inspired the development of swimsuits and other swimwear with the aim of improving performance for competitive swimmers. • The idea behind these swimsuits is to mimic the hydrodynamic properties of shark skin, particularly its reduced drag and enhanced speed. • Some features of these shark skin inspired swimsuits include: • Low-friction materials: The swimsuits are made from smooth, high-tech materials that reduce friction in the water, thereby reducing drag and improving a swimmer's speed.	10

2	• Compression: The swimsuits are designed to provide compression on the swimmer's body, which could help improve blood flow and muscle support during races.  Bio printing is an innovative technology that combines 3D printing with biological materials, such as living cells, biomaterials, and biomolecules, to create tissue-like structures or functional organs. **Bioprinting Techniques:** **(i)Inkjet Bioprinting:** This method uses a printer-like device to deposit small droplets of bio ink (cell-laden hydrogel) onto a substrate in a layer-by-layer manner. The bio ink contains living cells and supporting biomaterials. Inkjet bio printing is suitable for low-viscosity bio inks and is relatively fast but may suffer from limited cell viability due to shear stress during printing. **(ii)Extrusion-Based Bio printing:** In this technique, a bio ink is extruded through a nozzle to create a 3D structure. There are two main types of extrusion-based bio printing: • **Laser-Assisted Bio printing (LAB):** This non-contact bio printing method utilizes a laser to generate a focused energy pulse that transfers bioink to a substrate. The laser energy induces a process called "photothermal conversion," allowing the precise deposition of cells and biomaterials. LAB is known for its high-resolution capabilities and the potential to print delicate structures. • **Stereo lithography:** Based on photo polymerization, stereo lithography uses a laser or a digital light projector, to selectively cure a liquid photo polymer bio ink. This process solidifies the bio ink layer by layer, creating complex 3D structures with high resolution. • **Electro spinning:** This is a technique used to create nano fibrous scaffolds that can be used in combination with bio printed cells to enhance tissue regeneration. • The choice of bio ink is crucial in bio printing to ensure cell viability, proliferation, and appropriate functionality of the printed structures. Commonly used bio printing materials include: • **Hydro gels:** Hydro gels are water-absorbing polymer networks that mimic the extra cellular matrix (ECM) and provide structural support for cells. Examples of hydro gels used in bio printing include alginate, gelatin, collagen, hyaluronic acid, and fibrin. • **Cell-Laden Bio inks:** These bio inks contain living cells suspended in hydro gel or other biomaterials. Cells can be derived from various sources, such as stem cells, patient-specific cells, or cell lines, depending on the intended application.	10

3	.  • The term "electrical tongue" typically refers to an electronic device or system designed to copy the human sense of taste. • It is a type of sensor technology that aims to duplicate the human gustatory system's ability to detect different taste sensations such as sweet, salty, sour, bitter, etc;. • An electrical tongue works by using various chemical sensors, typically based on different technologies like ion-selective electrodes, surface plasma resonance, or impedance spectroscopy. • Each sensor is designed to respond to specific taste compounds or molecules. • When a sample is introduced to the electrical tongue, the sensors detect the presence and concentration of different taste compounds, and the data is processed to determine the overall taste profile of the sample. • The applications of electrical tongues are diverse and can include: • **Food and beverage industry:** Quality control and product development in the food and beverage sector. It can be used to analyze and optimize the taste of various products and ensure consistency in taste across batches. • **Pharmaceutical industry:** Assessing the taste properties of medicines and drug formulations. This can be important for improving patient compliance and acceptance of medications. • **Environmental monitoring:** Detecting and identifying taste-active compounds in water sources or environmental samples.	10
4.	 • The objective is to create artificial skin constructs that closely duplicates natural human skin and can be used for various medical applications, including wound healing, skin grafts, and in vitro testing for cosmetics and pharmaceuticals. • 3D Printing Process: • Cell Sourcing: The process begins with obtaining a sample of the	

	patient's skin cells or suitable donor cells. These cells are typically collected through a biopsy or other non-invasive methods. • Cell Culturing: The collected cells are then cultured and multiplied in the laboratory to obtain a sufficient number of cells for the 3D printing process. During the culturing stage, specific growth factors and nutrients may be used to encourage cell proliferation. • **Bio ink Formulation:** Bio ink is a crucial component used in 3D bio printing. It is a hydrogel-like substance that contains the cultured skin cells, along with other bioactive materials, such as proteins, growth factors, and collagen. The bio ink provides structural support and allows the cells to maintain their organization during printing. • **3D Printing Process:** The 3D bio printer deposits layers of the bio ink containing skin cells to create the desired skin construct. The printer's software ensures precise layer-by-layer deposition, following the digital model of the skin. •	10
5.	 • Artificial Intelligence (AI) has shown great promise in disease diagnosis and has the potential to revolutionize healthcare by improving accuracy, speed, and efficiency in diagnosing various medical conditions. • AI techniques, particularly machine learning and deep learning, have been applied to medical imaging, electronic health records (EHRs), and genomic data to assist healthcare professionals in diagnosing diseases more effectively. • Methods: • **Radiology:** AI can be used to aid radiologists in detecting and diagnosing conditions from medical imaging data. For example, AI models can help detect lung nodules in chest X-rays or identify signs of diabetic retinopathy in retinal images. • **Pathology:** AI is being used to assist pathologists in analyzing tissue samples for cancer diagnosis and grading. Automated image analysis can help identify and quantify cellular features, improving the	10

	accuracy and efficiency of pathology assessments. • **Dermatology:** AI-powered dermatology tools can assist in diagnosing skin conditions, such as melanoma or other skin cancers, by analyzing images of skin lesions. • **Genomic Data Analysis:** AI can analyze genomic data to identify genetic markers associated with specific diseases, enabling personalized medicine and early disease detection based on an individual's genetic profile. • **Electronic Health Records (EHRs):** AI can process vast amounts of data from EHRs to predict disease risk, identify potential drug interactions, and assist in clinical decision-making. • **Virtual Assistants and Chatbots:** AI-driven virtual assistants and chatbots can help patients navigate their symptoms, provide initial diagnosis suggestions, and offer healthcare advice before seeking in-person medical attention. • Medical Imaging: AI algorithms can analyze medical images, such as X-rays, MRI scans, CT scans, and histopathology slides, to detect abnormalities and assist in diagnosing conditions like cancer, heart disease, fractures, and more**.**	10
6	 • The lotus leaf is well-known for having a highly water-repellent or super hydrophobic surface, thus giving the name to the lotus effect. • The Lotus Leaf Effect is based on two key features: • Microscopic Structure: Lotus leaves have a unique microstructure on their surface, consisting of numerous tiny wax-covered bumps. • These bumps are hydrophobic, meaning they repel water. • When water droplets come into contact with the lotus leaf, they rest on top of these microstructures, minimizing the area of contact between the water and the leaf surface. • **Self-Cleaning Mechanism:** Due to the water-repellent nature of the lotus leaf, when water droplets roll off the surface, they pick up and carry away dirt, dust, and contaminants from the leaf. • High Contact Angle: The water droplets on the lotus leaf form nearly	10

7	spherical shapes with very high contact angles, typically exceeding 150 degrees. • A high contact angle means that the water droplets minimize their contact with the surface and tend to bead up and roll off the leaf easily. • Low Sliding Angle: The sliding angle is the angle at which a water droplet starts to roll off a surface due to gravity. • The lotus leaf has a very low sliding angle, often less than 10 degrees. •  • Self-healing bio concrete, is a type of concrete that has the ability to repair cracks or damage autonomously without the need for human intervention. • This innovative material is designed to mimic the natural self-healing properties of living organisms, such as bacteria, that can repair and regenerate themselves. • The concept of self-healing bio concrete typically involves the incorporation of special agents or microorganisms within the concrete mix. • When cracks form in the concrete due to various factors like shrinkage, stress, or environmental exposure, these agents become activated and initiate the self-healing process. • **Bacteria-Based Self-Healing:** Certain types of bacteria, such as Bacillus bacteria, can be embedded in the concrete mix. • When moisture enters a crack, it activates the bacteria, which produce calcium carbonate as a by-product. • This calcium carbonate fills the crack and forms a new mineral, effectively sealing the damaged area. • **Capsule-Based Self-Healing:** Concrete can be mixed with tiny capsules containing healing agents, such as polymer or mineral-based solutions. • When cracks occur, the capsules rupture, releasing the healing agents to seal the cracks.	

End of Scheme