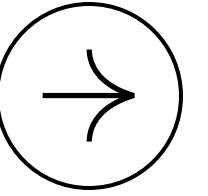


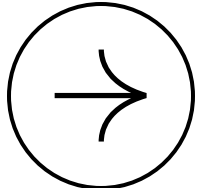
Coral reef 3d printed substance



MURJAN

HANEEN KHALEEL

Coral reef 3d printed substance



only 49 World Heritage Sites have been formally described for marine values. and Diversity "unesco"
Aqaba - biodiversity

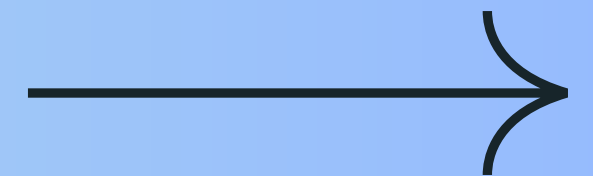


Bleaching Crisis

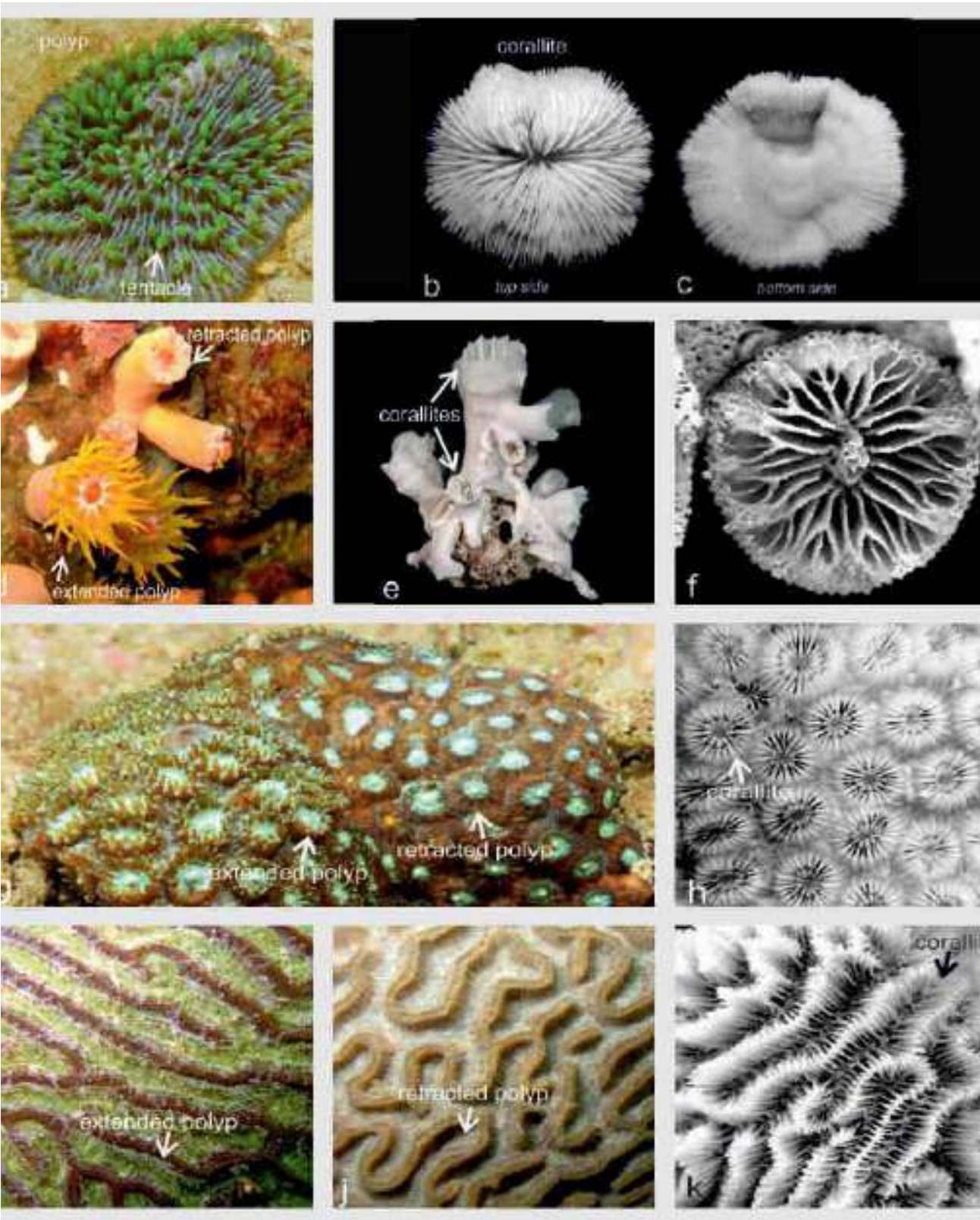
2024

Importance of Marina Reefs

Coral reefs cover only 1% of the world's oceans floor but provide habitat for at least 25% of all marine life.



Some of Corals in Aqaba Gulf



Hard Corals



Introducing Clay as a Low- Carbon Material



Abundant Resource

Clay is a widely available natural material.

Low Carbon Footprint

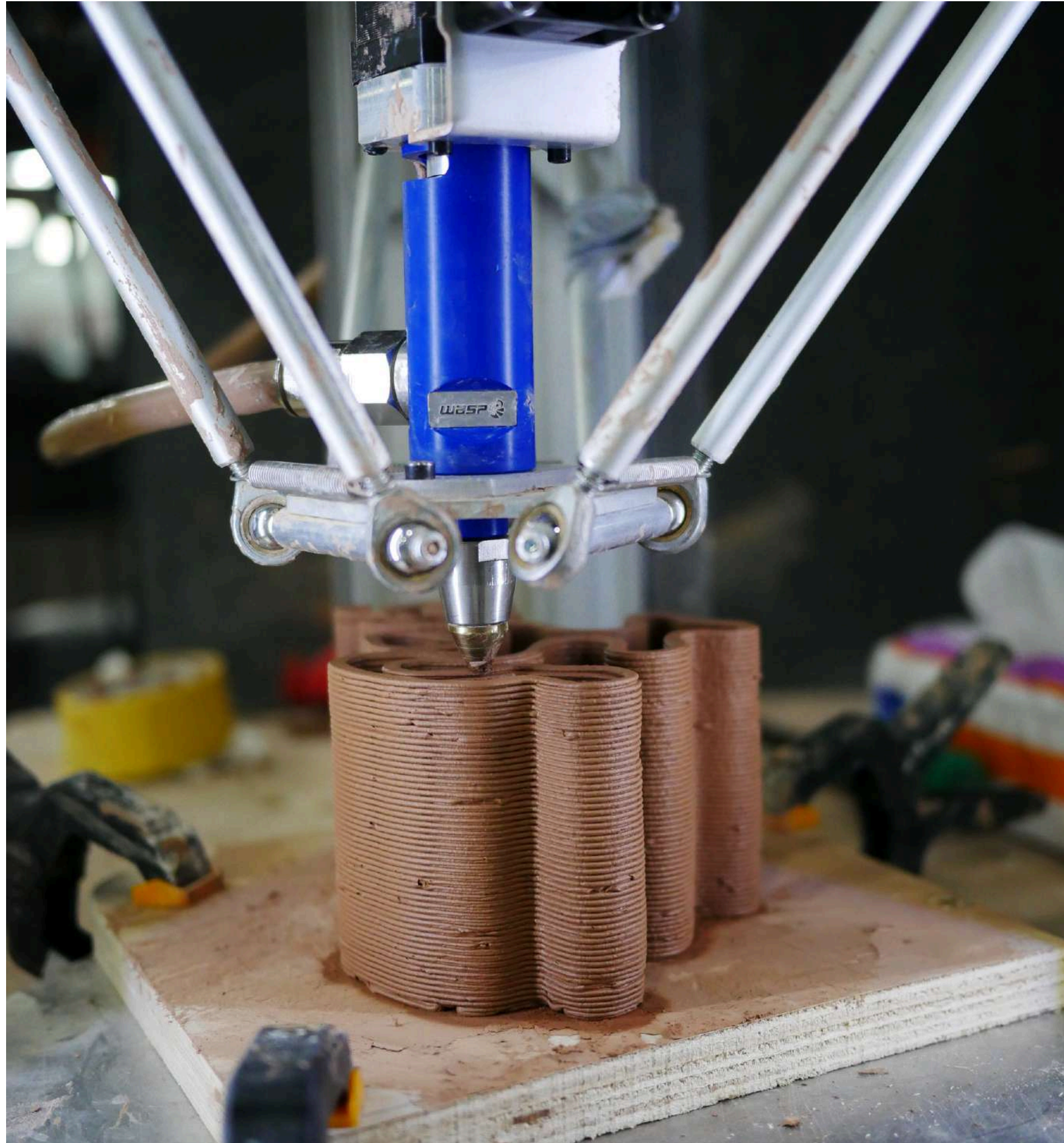
It produces significantly less carbon than plastics.

Biocompatible Material

Clay supports marine life and ecosystem health.

Biocomposite Material

Clay can be mixed with other natural materials to strengthen it.

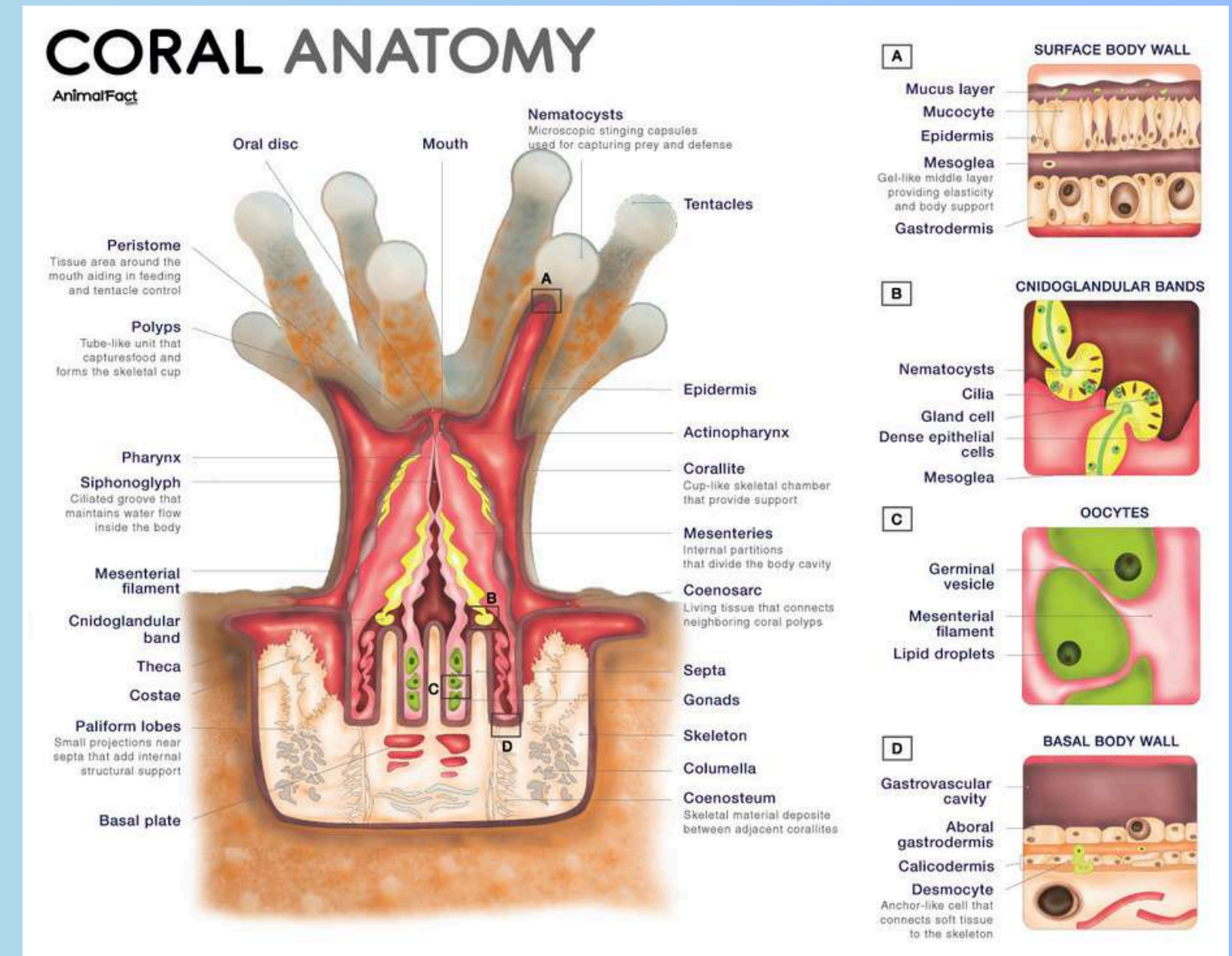
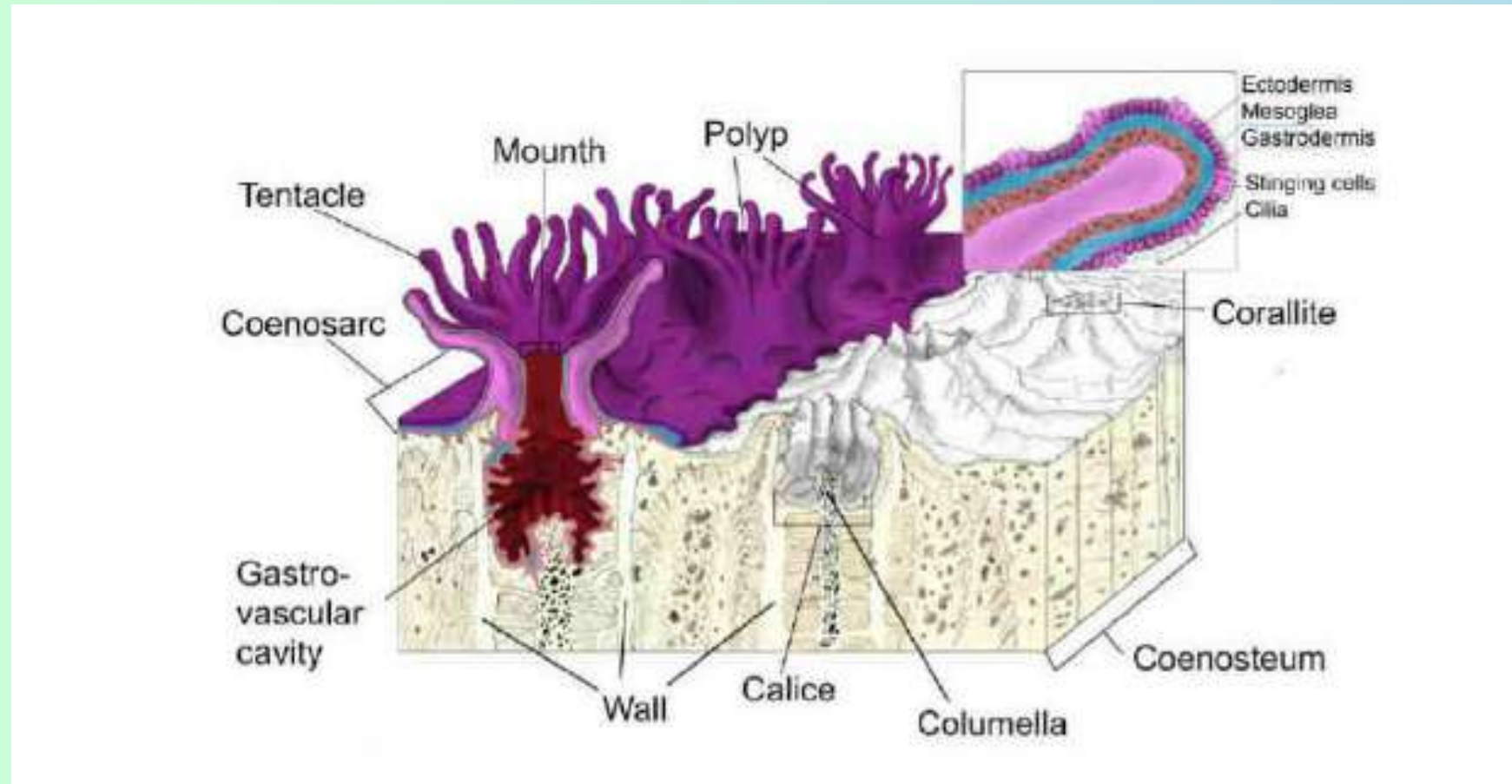


3D Printing Technology

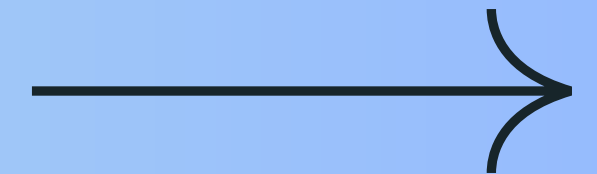
Clay 3D printing technology enables the creation of **complex and customizable** reef structures tailored for coral restoration. This innovative method allows for intricate designs that mimic natural corals, promoting marine habitat growth while maintaining a low carbon footprint, essential for environmental sustainability.

Cases

Designing for Restoration

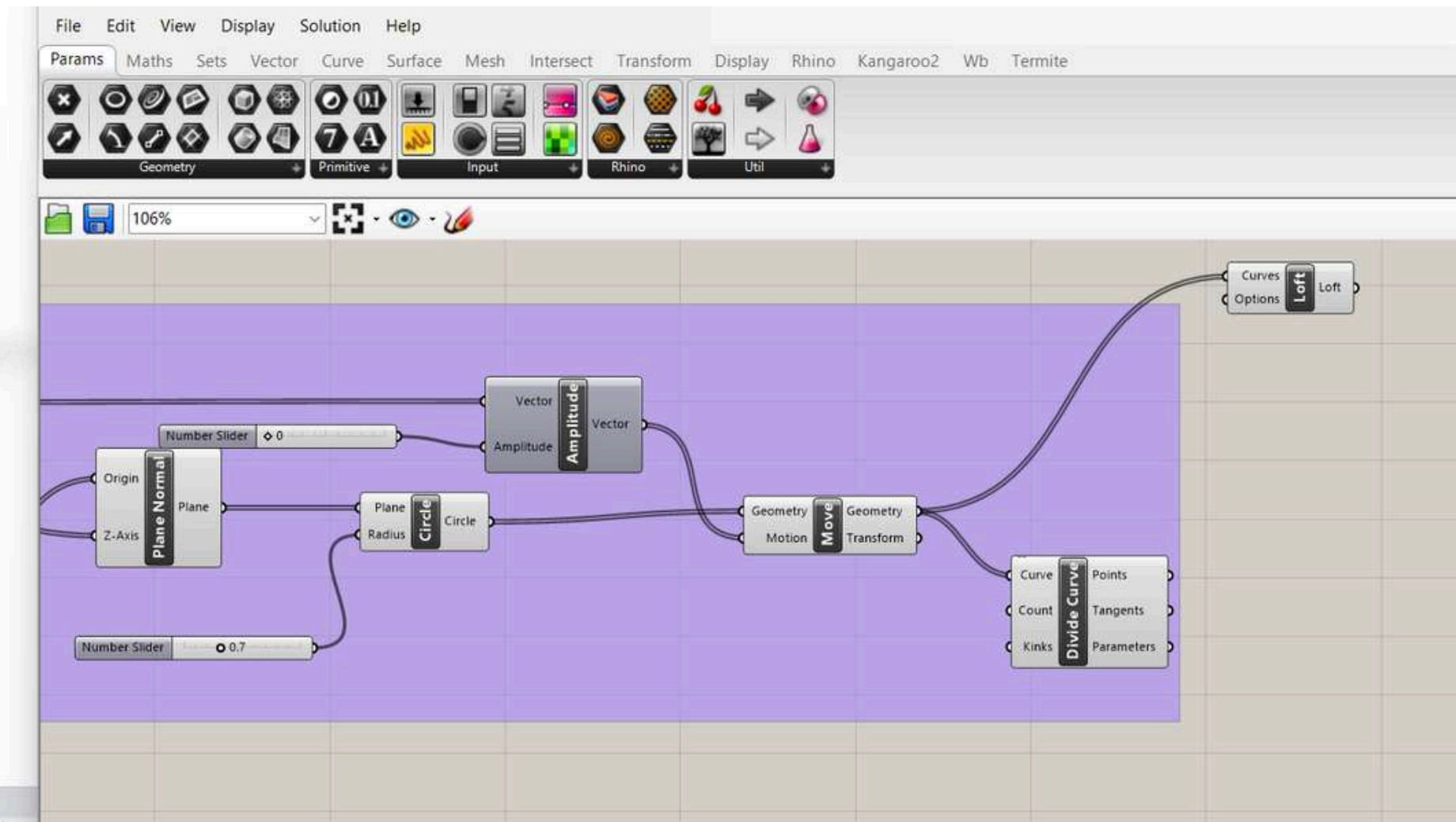
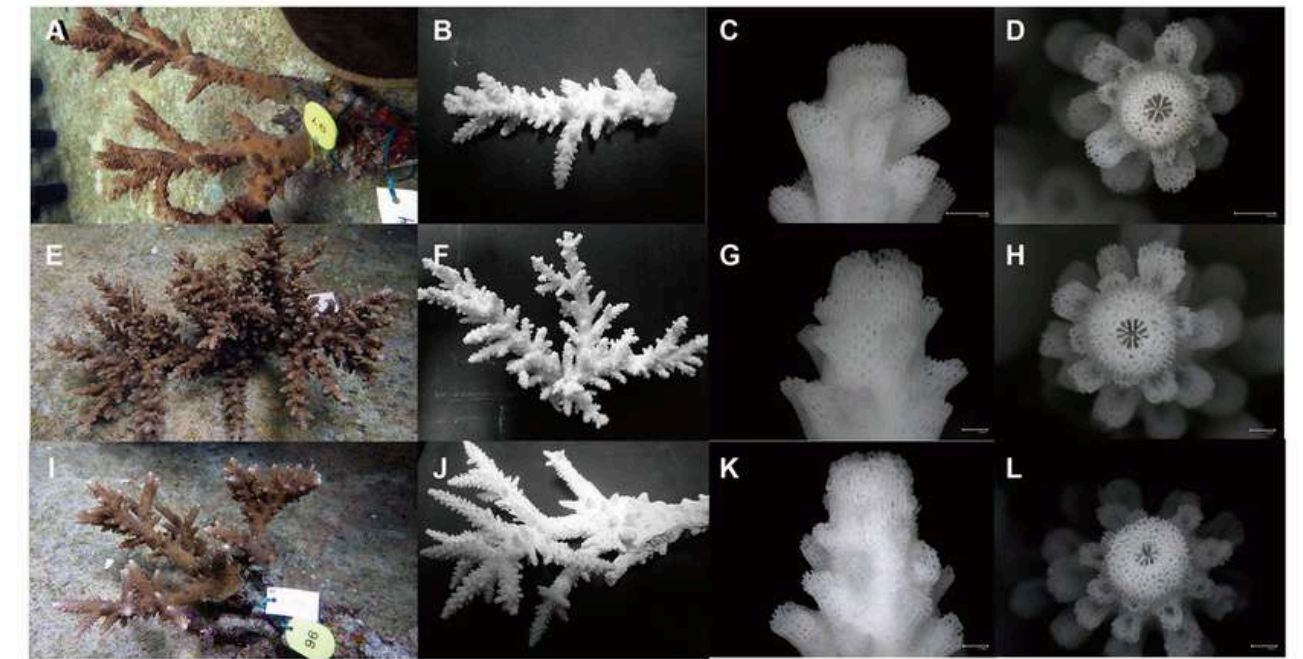


The design is inspired by **coral structures**, providing essential habitats for marine life. These durable yet porous creations support growth and resilience in rapidly changing environments.



Initial Design Concepts

Exploring innovative reef structure models



The early prototypes showcase experimental shapes designed to mimic natural coral forms, promoting habitat growth and enhancing marine biodiversity, crucial for successful reef restoration efforts.

Python

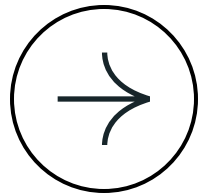
equations to generate fractals

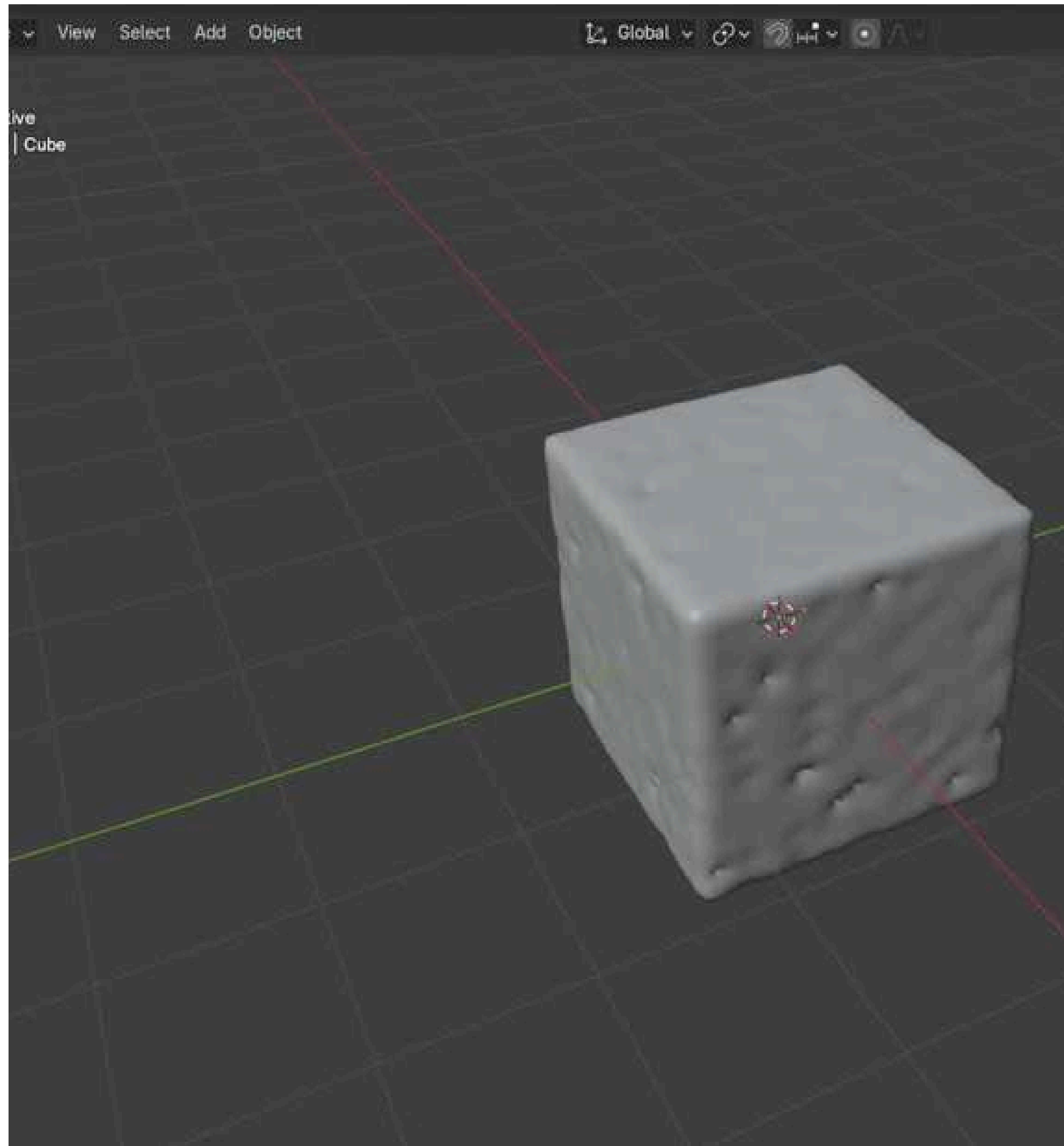
The image displays a workflow for generating a fractal tree in Rhino 8 using Grasshopper and Python. The main window shows a 3D perspective view of a tree-like structure composed of numerous small spheres. The Grasshopper interface on the right shows a script editor with the following Python code:

```
branch_sphere = rg.sphere(branch_pos, radius * 0.7)
branch_meshes = rg.Mesh.CreateFromBrep(branch_sphere.ToBrep(), rg.MeshingParameters.Default)
if branch_meshes:
    final_mesh.Append(branch_meshes[0])
grow_coral(branch_pos, size * 0.7, level - 1)

grow_coral(rg.Point3d(0, 0, height * 0.6), height * 0.4, levels)

# ADD POLYPS
for i in range(25):
    polyp_pos = rg.Point3d(
        random.uniform(-1.5, 1.5),
        random.uniform(-1.5, 1.5),
        random.uniform(height*0.4, height)
    )
    polyp = rg.Sphere(polyp_pos, radius * 0.3)
    polyp_meshes = rg.Mesh.CreateFromBrep(polyp.ToBrep(), rg.MeshingParameters.Default)
    if polyp_meshes:
```





Design Gyroid Geometry

Using Blender with a visual script
 $\cos(x) \cdot \sin(y) + \cos(y) \cdot \sin(z) + \cos(z) \cdot \sin(x) = 0$.

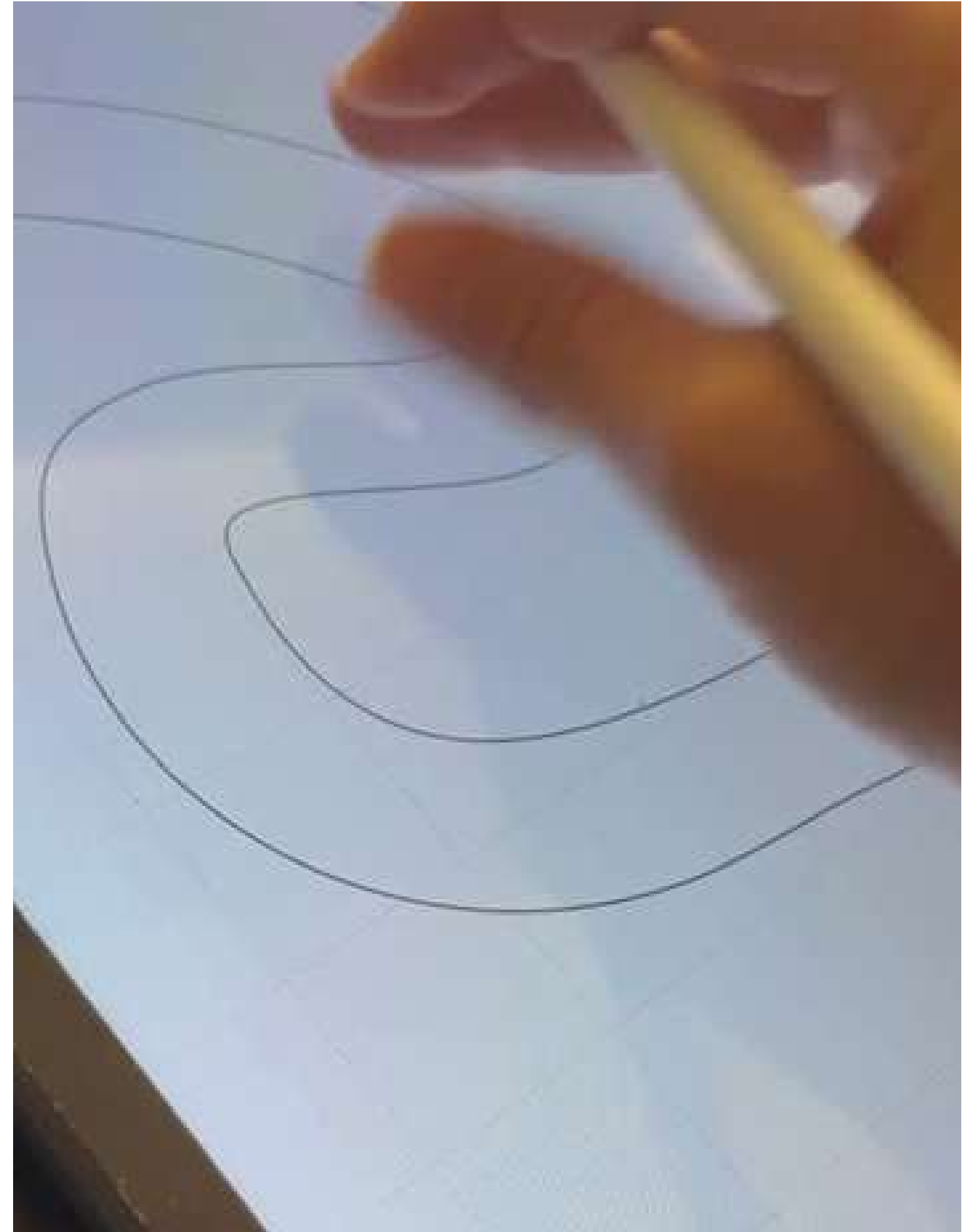
Design

01 Enviroment

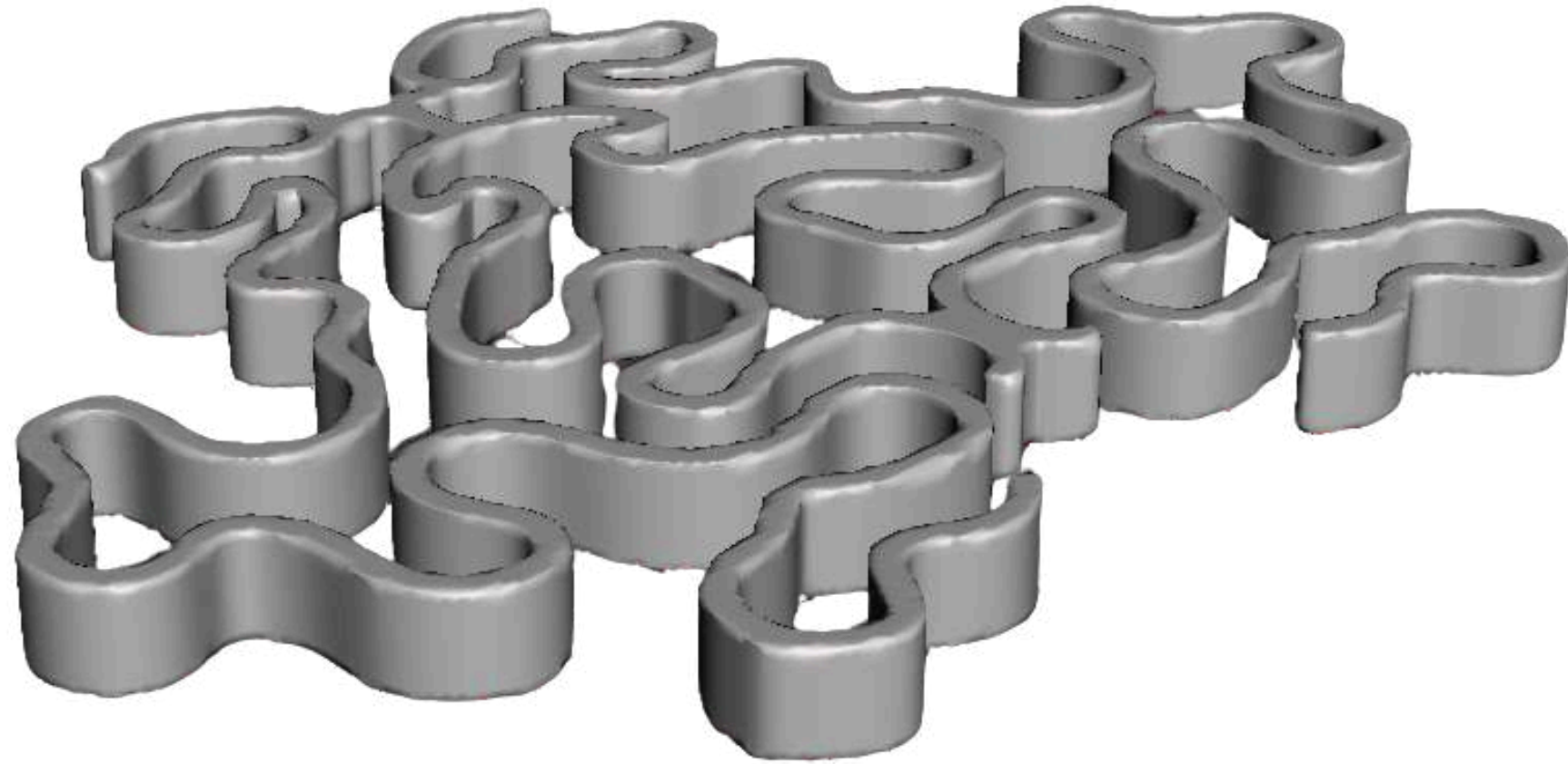
work on the environment by decreasing the water flow
enough solid surface for coral to grow and other species.

02 Clay

continuous toolpath for clay 3d printer

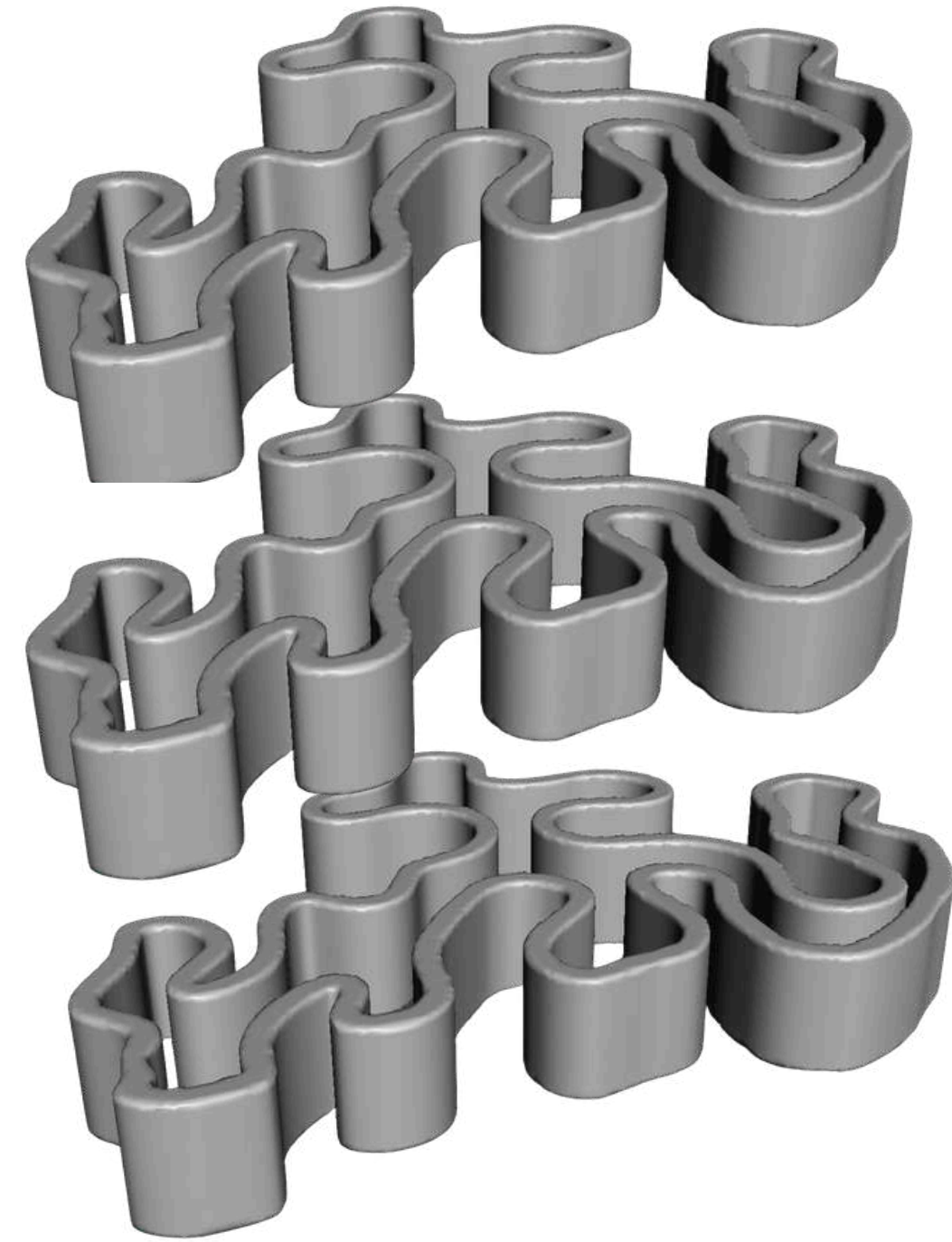


Design



Inspired from Aqaba corals such as Brain Coral

Allow water and other species to go through the opening in geometry
and even inhabit more marina species



Staked Modules



Clay Firing

Fired at 1030 - considered **earthware clay**.
Some clay can turn into **stoneware** if fired
above 1200.



Before firing - electrical for sharp edges.



After Firing -Terracota

Fill opening





Challenges and Solutions

Durability

Clay's durability in marine environments requires careful adjustments.

Marine Acceptance

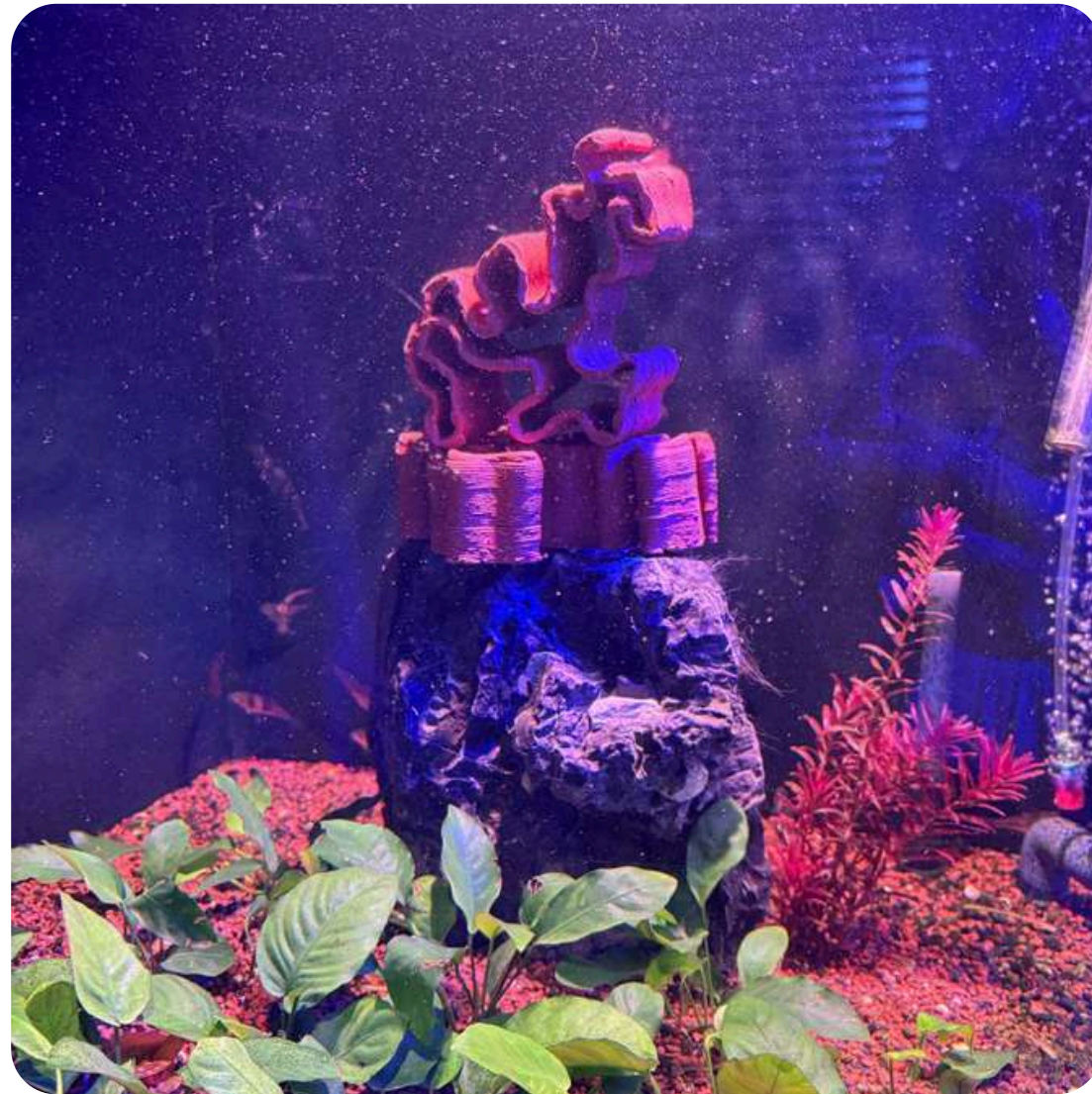
Bio-mimicry improves acceptance of clay structures by organisms.

3D Printing

Printer calibration is essential for underwater shape accuracy.

Material Tweaks

Continuous material tweaks enhance performance and longevity underwater.



tested in different sea water, with different level of bacteria, marina life and PH