WEST PORT
ARCHITECTURE AND DESIGN

BUILD YOUR OWN BIODOME

In this lesson you will learn about Biodomes and what to consider when designing and building one. You can also create your own model of a biodome structure and its ecosystem.

RIBA

WHAT IS A BIODOME?

A biodome is a structure which provides a controlled and self-sustained habitat for plants and animals. Biodomes are not greenhouses!

They create their own water, nutrients and survive with very little or no help from the outside. One famous example can be found in Cornwall, called the Eden Project. It consists of many biodomes.

They are built in a very specific way to help plants and animals grow in a safe environment so that we can learn about them.

The Eden Project, UK (1)

Cloud Forest, Singapore
Photo by Nick Fewings on Unsplash

Montreal Biodome, Canada (2)

(1) Source: https://en.wikipedia.org/wiki/Eden_Project#/media/File:Eden_project.JPG
(2) Photo by PtitLutin Source: Wikipedia: https://en.wikipedia.org/wiki/Montreal_Biodome#/media/File:Biodome_Montreal.jpg

BENEFITS OF A BIODOME

Biodomes replicate different ecosystems such as the Desert, the Arctic, the Amazon jungle and so on, without a person having to physically visit these places. In biodomes, people can learn about the behavior of all different kinds of plants, insects and ecosystems.

These structures can help preserve endangered plants and animals and create a beautiful outdoor area that is self-sufficient and sustainable. It also saves money, energy and water because of its regenerative properties..

Advantages of a biodome structure:

- Plants grow quicker than other seedlings.
- They are stronger and more resilient.
- They are more likely to survive transplanting into the garden.
- There is less chance for viruses and bugs to attack the plants.
- The plants do not suffer from burning, or receiving too much or too little of a certain nutrient, as the biodome is not tampered with or exposed to the outside environment.

Tropical Rainforeast
The Eden Project, UK

Penguins at the Montreal Biodome
Source: Wikipedia,

Fog Desert, Biosphere 2, USA
Photo by: Aspersions, Source: Wikipedia

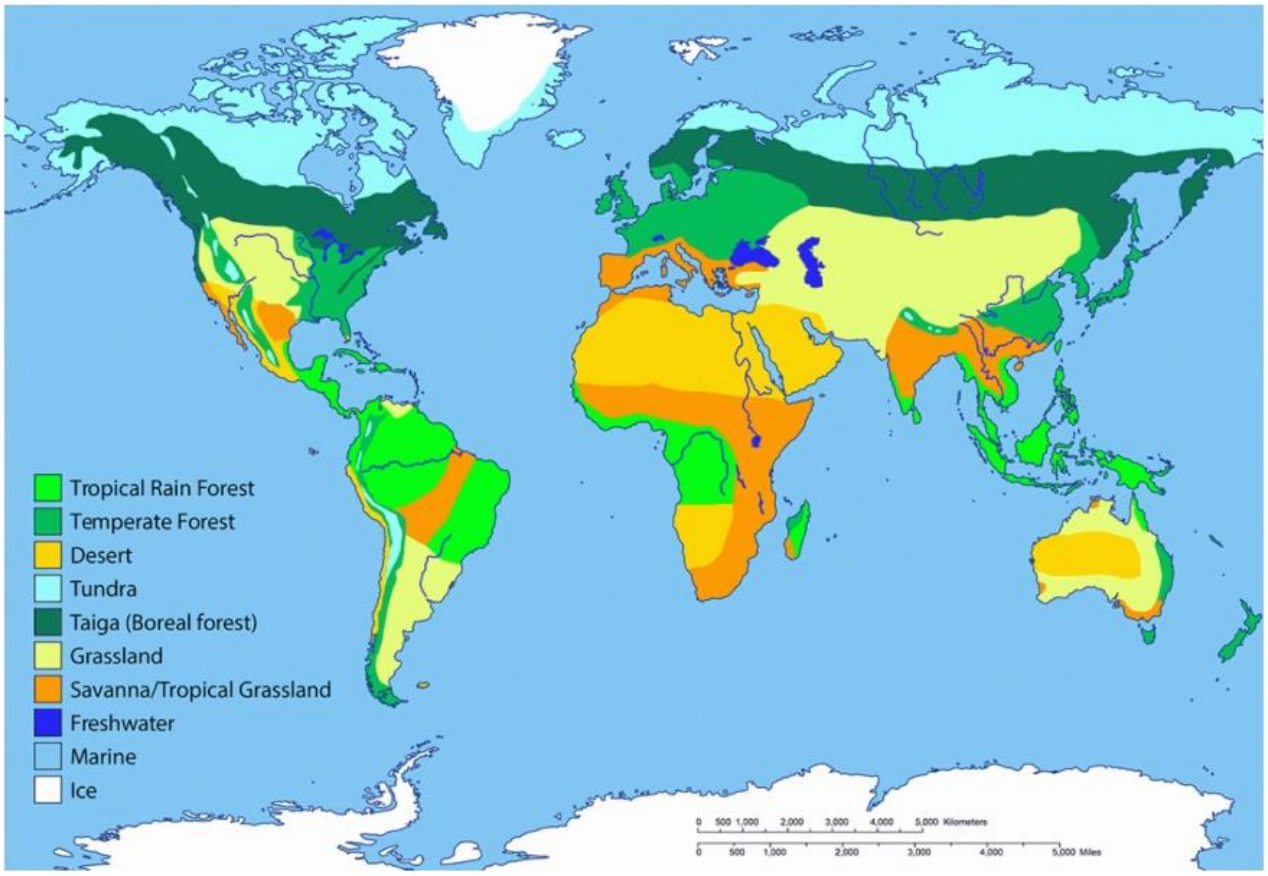
ECOSYSTEMS AND BIOMES

Earth consists of numerous ecosystems, defined by the interaction of animals, plants and minerals in an environment. These ecosystems can be grouped into biomes - geographic areas, defined by climate, precipitation, evaporation and types living organisms and nonliving matter.

Below are examples of different biomes. Find differences and similarities between them.

- Can you see how humidity, temperature, altitude can affect the environment and the appearance of the animals?
- Can you see the patterns in food chain, the size of animals? What do they eat? Where do they find shelter?

Each ecosystem has its own food chain which significantly contributes to maintaining balance in the environment. Lack of certain food, shelter, or type of animal can cause severe imbalance and bring damage to the environment. This is why it's important to maintain BIODIVERSITY in the food chain, also when designing a BIODOME.



Map Source: https://askabiologist.asu.edu/explore/biomes

GRASSLAND

Grasses grow where there is not enough moisture to support trees, where rainfall is from 10-30 inches a year. Water evaporates more quickly when it is warmer, so effectively the grasslands get less water for the plants to use.

Grasslands are usually located between deserts and forests. They ar also located where trees are unable to adapt i.e. in very cold areas or in the high altitudes.

- Warm temperatures
- Rainfall: 10-30 inch a year

GRASSLAND

TERTIARY COMMUNITIES


lion


hyena


eagle

SECONDARY COMMUNITIES


Pangolin (4)


mongoose

PRIMARY COMMUNITIES


impala


mouse


dung beetle (5)

PRIMARY PRODUCERS

(4) Pangolin: https://en.wikipedia.org/wiki/Pangolin#/media/File:Manis_temminckii_(29390603130).jpg -Credit: U.S. Fish and Wildlife Service Headquarters - Manis temminckii

(5) Dung Beetle: https://commons.wikimedia.org/wiki/File:Scarabaeus_laticollis_2.jpgphoto by Rafael Brix; source: Wikipedia

DESERT

A desert is a place that has few, or sometimes even no, life forms. Sometimes life forms adapt to living in deserts, but conditions tend to be extreme, and survival is challenging.

Some deserts can be visited but not lived in. Some deserts are so inhospitable that life as we know it cannot survive in them at all.

In terms of rainfall, areas that receive less than ten inches of rain a year are considered to be deserts.

Some deserts receive only three or four inches of rain a year. A few places do not receive any rain at all. The temperature differences (amplitudes) are so high, that only the most resilient animals can survive here.

- Extreme temperature changes
- Rainfall: <10 inch a year

DESERT

TERTIARY COMMUNITIES

hawk

coyote

SECONDARY COMMUNITIES

snake

scorpion

spiders

PRIMARY COMMUNITIES

kangaroo rat (6)

lizard

ants

PRIMARY PRODUCERS

(6) Kangaroo Rat: Public Domain, https://commons.wikimedia.org/w/index.php?curid=338979

DECIDUOUS TREES

In this temperate zone biome, rainfall varies from 30 to 60 inches a year. Humidity may be high. Summers are warm, but winters are cold, and there is often snow. There are four definite seasons.

This biome is home to many kinds of deciduous flowering trees. Deciduous trees need a growing season of about 120 frost-free days. In spring they draw on their reserve food to make new leaves. This takes time in the cool spring weather. By early summer their leaves have grown and the trees can use some of the food that the leaves create to build up their energy reserves and make seeds. In the autumn the leaves change color as the tree draws as much nourishment as possible from them. Then the leaves fall. When the snow comes only a little of it weighs down the bare branches.

Many of these trees rely on insects for pollination. Some have beautiful flowers, and fruit that is edible. Many of our fruit trees have come from wild varieties that grow in deciduous forests.

- Hot summers and cold winters (snow)
- Rainfall: 30-60 inch a year

DECIDUOUS TREES

TERTIARY COMMUNITIES

bear

cougar

SECONDARY COMMUNITIES

fox

owl

skunk

PRIMARY COMMUNITIES

Earthworms (7)

deer

small birds

bees

PRIMARY PRODUCERS

(7) Earthworms: https://en.wikipedia.org/wiki/Earthworm#/media/File:Earthworm.JPG

TAIGA (BOREAL RAINFOREST)

Evergreen coniferous forests, which are also called TAIGA, begin where tundra gives way to trees. These forests grow over a large area of earth's land, extending toward warmer regions. The climate in evergreen forests is pleasant in summer, when temperatures may rise into the eighties and evenings are cool. Winters, however, can be very cold, dropping to -65 degrees Fahrenheit in some areas, but barely falling below freezing in others.

Rainfall in this biome varies from 12 to 33 inches a year. Some of this moisture comes in the form of snow, and sometimes young trees are buried by snow in the winter. This covering of snow protects the trees from intense cold and dehydration by icy winds.

- Warm summers and cold winters
- Rainfall: 12-33 inches a year

TAIGA

TERTIARY COMMUNITIES

wolf

lynx

SECONDARY COMMUNITIES

owl

fox

skunk

PRIMARY COMMUNITIES

moose

chipmunk

beetle

PRIMARY PRODUCERS

TROPICAL RAINFOREST

Rain forests receive over 60 inches of rain a year. That is five feet of water!

These forests are found next to oceans, where evaporation fills the air with water vapor. As the ocean air sweeps over the land, the moisture comes down as rain.

Rain forests are filled with plants of different heights. As the sunlight is filtered through the leaves, sometimes the air looks almost green.

There are two kinds of rain forests: tropical and temperate.

Tropical rainforests are found near the equator. They have very rich ecosystems, with many kinds of plants and animals living together.

Temperate rainforests are cooler, and have fewer species living in them. They provide ideal conditions for conifers, mosses, ferns, and fungi.

- Stable day and annual temperatures.
- Rainfall: >60 inches a year

TROPICAL RAINFOREST

TERTIARY COMMUNITIES

boa

jaguar

SECONDARY COMMUNITIES

frogs

bats

toucan

PRIMARY COMMUNITIES

sloth

monkey

butterfly

grasshopper

PRIMARY PRODUCERS

TUNDRA

The Tundra Biome provides examples of adaptation to extreme conditions. It is found next to the icy zones in the arctic. (If there were land at those latitudes in the southern hemisphere, tundra might be found there, too, but this is not the case on earth right now).
There is also Alpine Tundra high on the slopes of mountains.

During most of the year temperatures on the tundra are below freezing and may sometimes drop to as low as -50 degrees Celsius. There are powerful winds that can blow up to 100 miles an hour. As a result of the cold, the water in the ground freezes: the ground can be frozen as deep as 30m below. The part of the ground that thaws is called the active layer. This layer is very wet, because the water from the melted ice cannot drain away. Grass, moss and shrubs are the main plants growing in this region, and hardly any trees. In fact, tundra in finnish means 'treeless'.

- Stable day and annual temperatures.
- Rainfall: <10 inches a year

TUNDRA

TERTIARY COMMUNITIES

arctic fox

polar bear

SECONDARY COMMUNITIES

seal

trout

PRIMARY COMMUNITIES

arctic hare

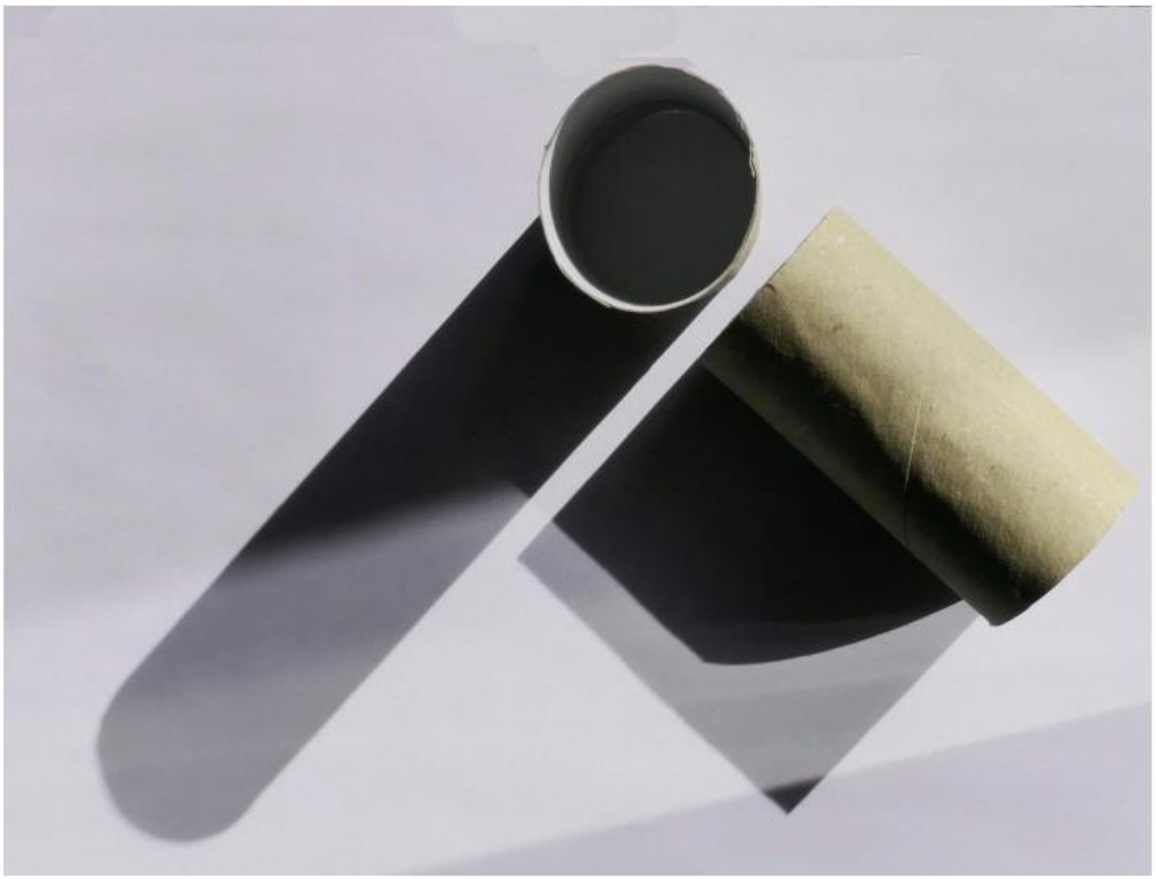
caribou

shrimp

PRIMARY PRODUCERS

HOW TO BUILD A BIODOME STRUCTURE

(from a toilet roll)



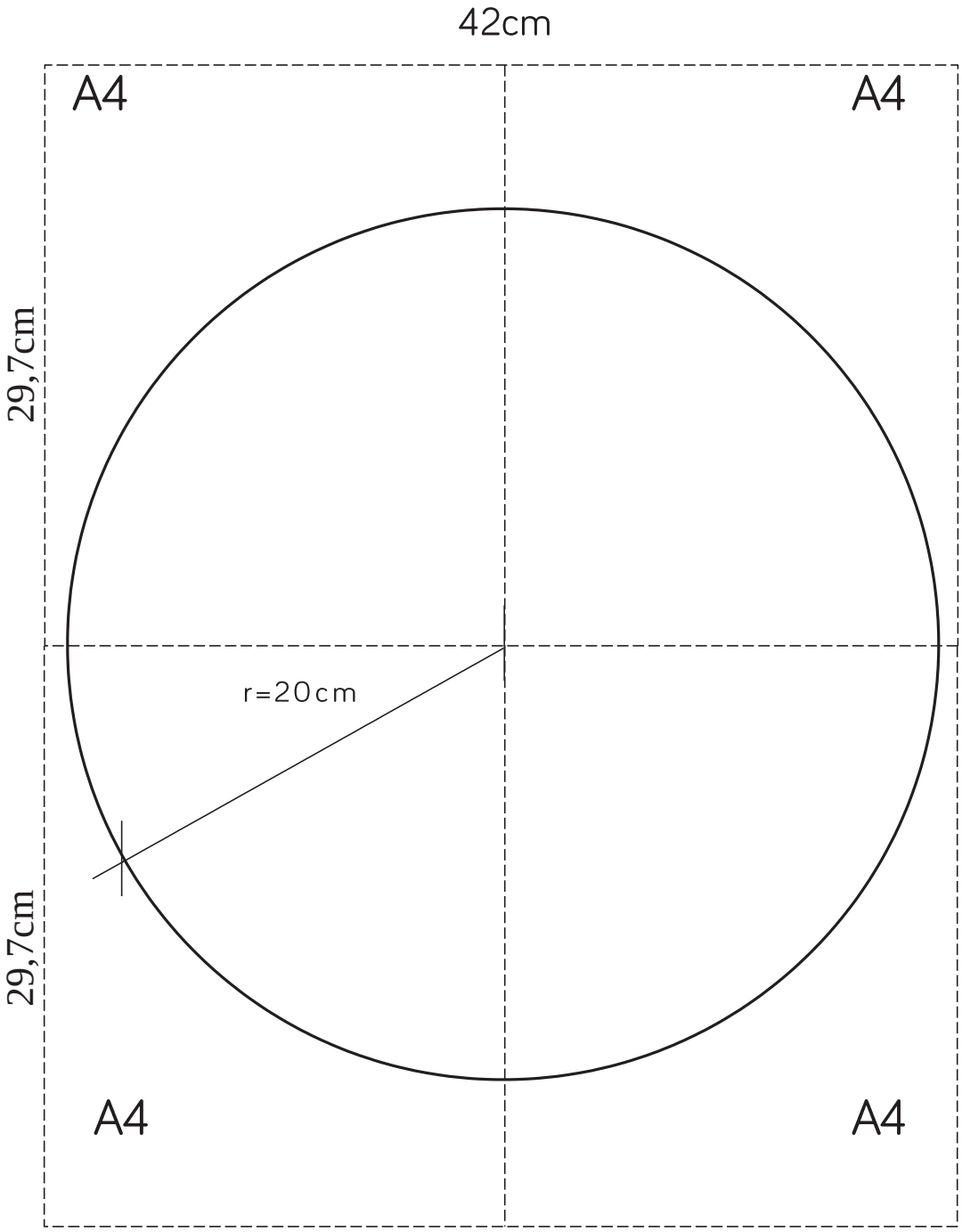
BIODOME STRUCTURE

A biodome is a big structure and requires modular and lightweight system in order to support large spans. These modules can be triangles, rectangles and hexagons. Can you think of any other modules that make up a biodome?

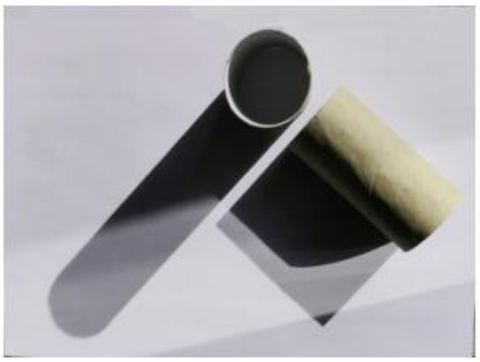
MAKE A BASE

Get 4x A4 sheets of paper and connect them wth a tape underneath to form one big sheet of paper. Create a circle with a radius of 20cm. It will become the footprint of your biodome project.

Plan your space inside it, based on your chosen biome and sketches.

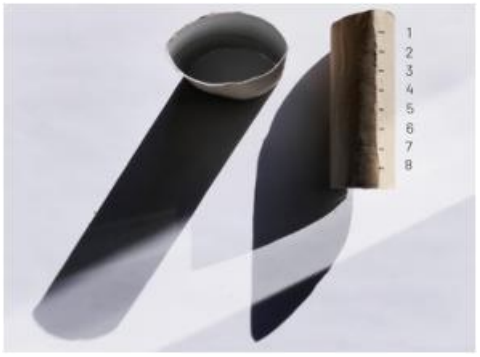


CREATE MODULES



Step 1:
Collect 9 toilet rolls. If you don't have them, see next page for an alternative way to get to step 4.

Step 2:
Prepare sharp scissors, ruler, marker and a tape.



Step 3:
Squash the toilet rolls, mark points every 1cm with a ruler and use scissors to cut out rings.

Step 4:
You should have 9 rings from one toilet roll.

Step 5:
Pick three rings and three paper clips.

Step 6:
Connect 3 rings with paper clips, always from the same side. Make sure that the rings retain their original circular shape.

Step 7:
Replace the paper clip with a tape, sticking only the top edges together!

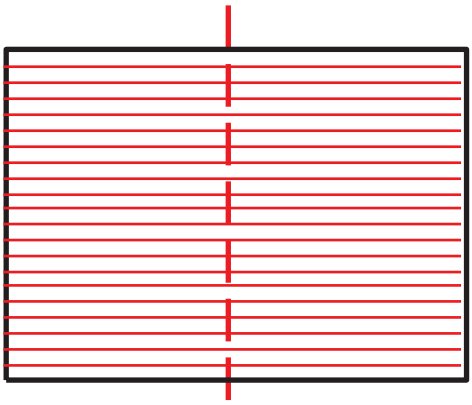
Step 8:
When you replace all paper clips with tape, lift the circles to ensure that one side of rings is firmly connected, and the other one is open and bends.

NO TOILET ROLL? NO PROBLEM!

You can make your own rings out of paper. Just follow the below steps to create 79 rings:

1. Get 2 x A4 sheets of card, ideally cardboard. Draw 1cm lines along the shorter edge. You should have 21 strips.

2. Fold in a half and cut all strips along all drawn lines.

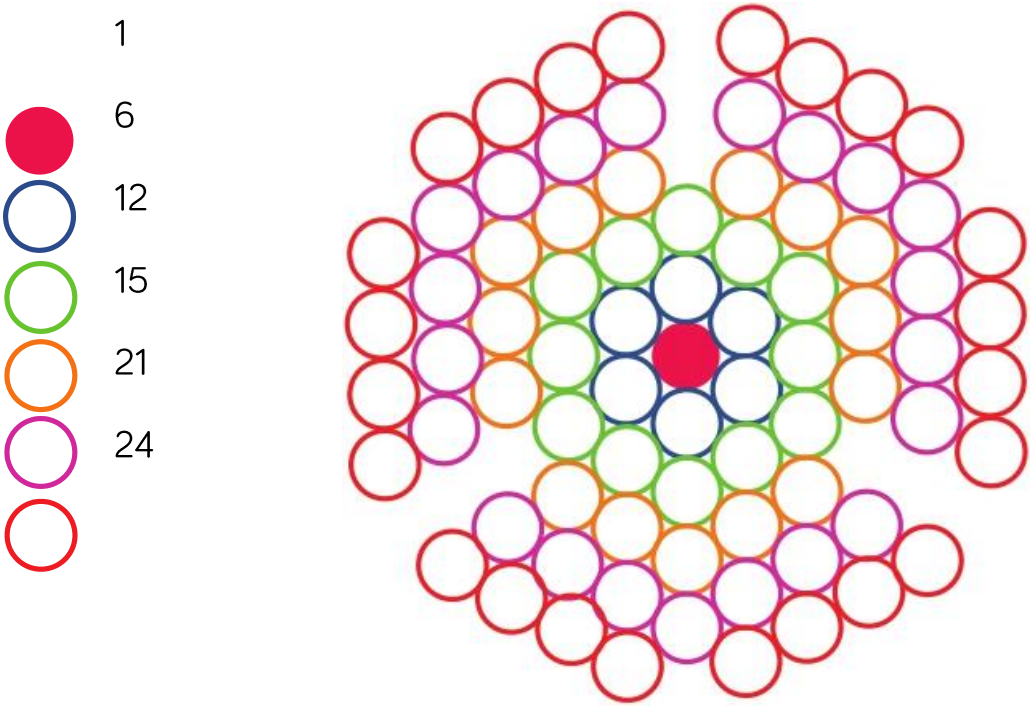


3. You should have now 84 strips. Fold into a ring with a 1cm overlap and staple or glue together.

FORM A PATTERN

Continue connecting the circles, first with paper clips, and then replacing with a tape to ensure that the rings are connected in the right place.

Follow the following template to create the below patter made of 79 rings.

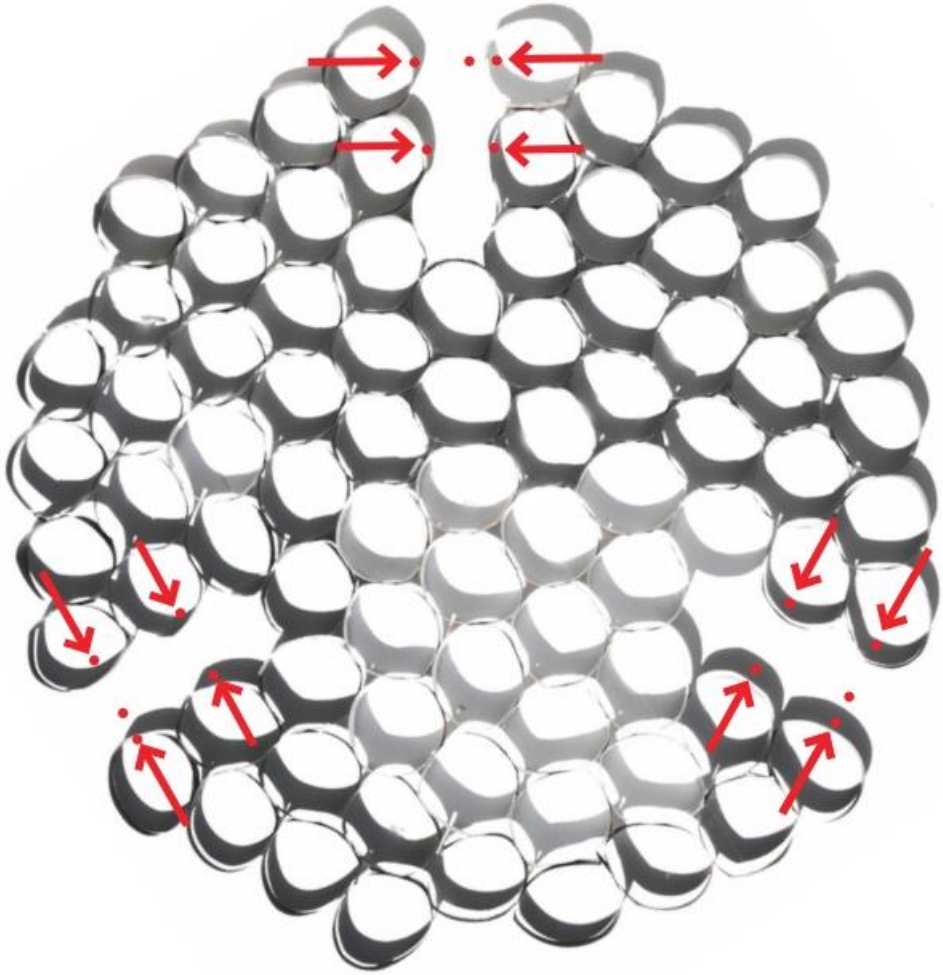


Lift the whole pattern from the centre. It should resist bending

If you flip the pattern upside down it should fold naturally.

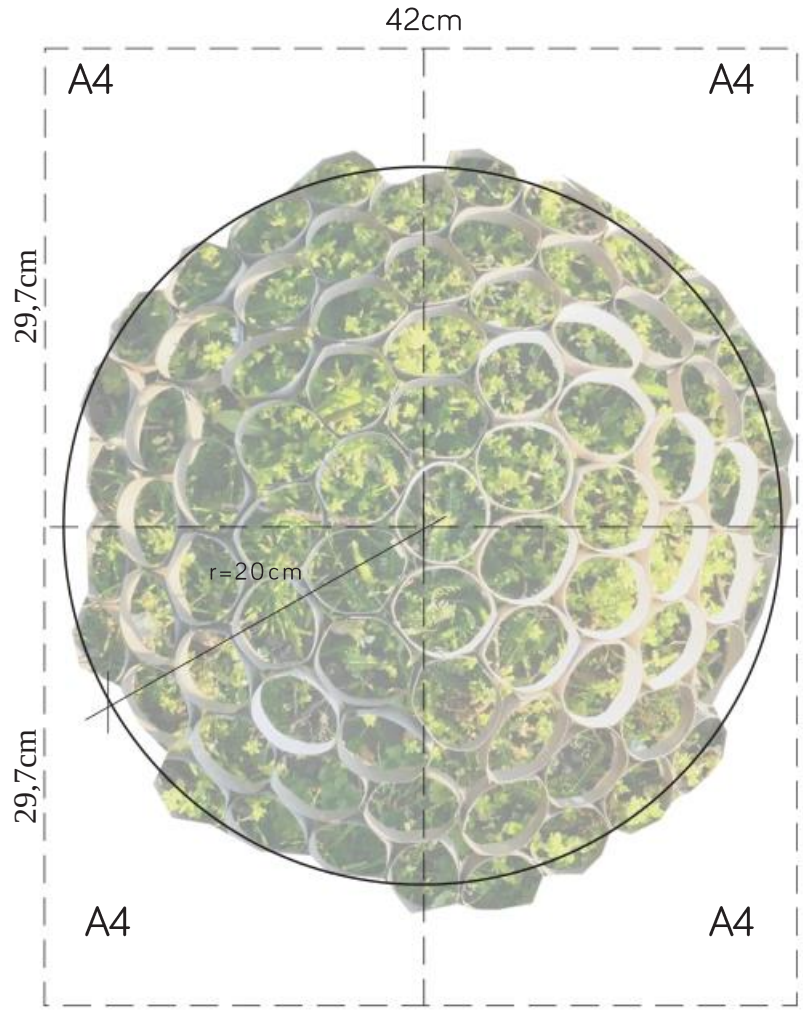
MAKE A DOME

Connect the circles together in the following locations



Now your flat pattern should bend into a dome

BIODOME ON THE GRASS



Take photos of your biodome in context and tag:
@RIBALearning on Twitter and use the #ArchitectureAtHome

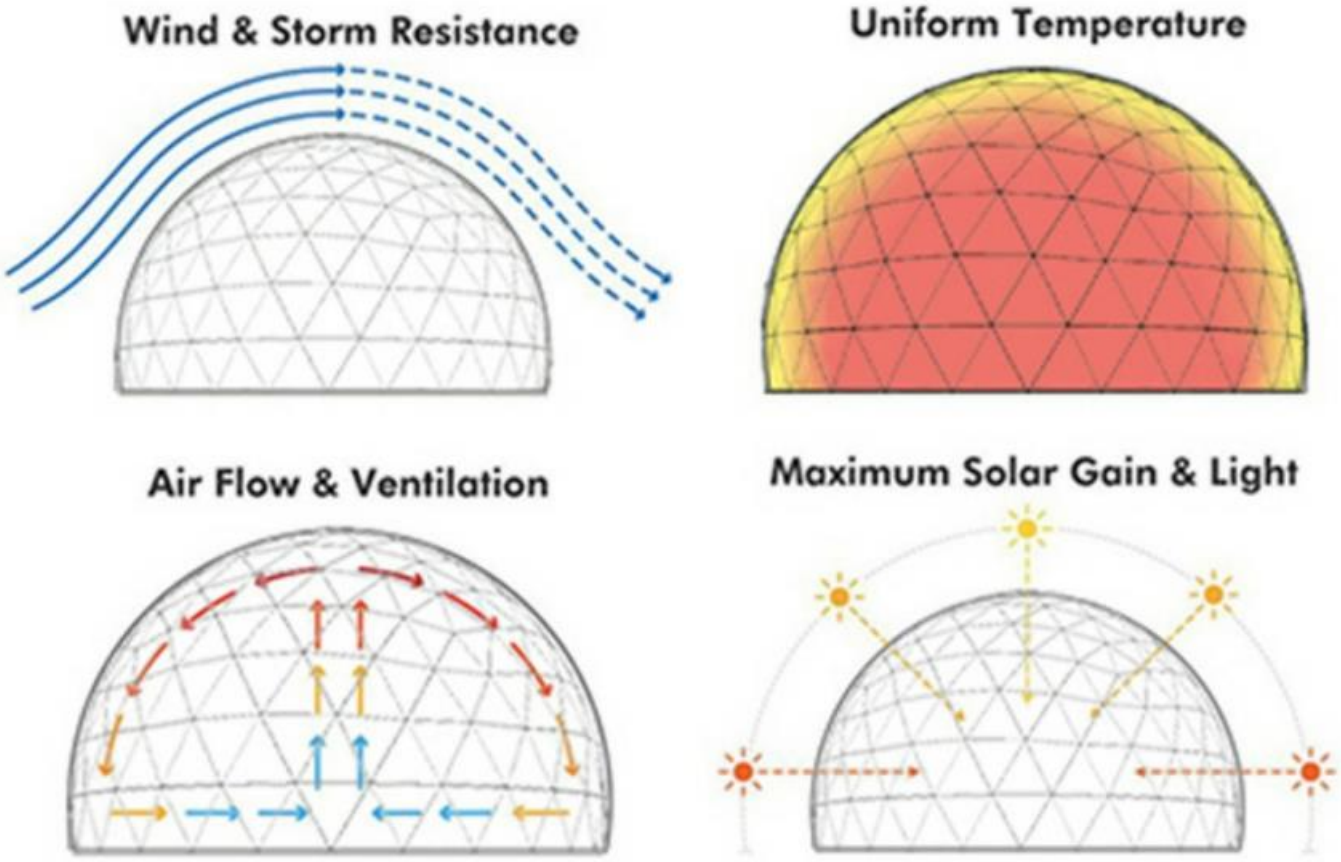
DESIGN YOUR ENVIRONMENT

What are you going to put inside your biodome? Choose one of the provided BIOMES and recreate an ECOSYSTEM under your structure. Below are some examples of different environments created by young architects.

Take photos of your biodome in context and tag:
@RIBALearning on Twitter and use the #ArchitectureAtHome

BIODOME OPERATION

Once the biodome is closed up and sealed from the outside world, the entire life cycle process continues on its own.
A biodome is a complex system, mimicking light, temperature and humidity of an eco-system. What does your biodome need to consist of in order to keep your organisms alive? Does it need to provide a lot of light or water? Will it need to capture heat or protect it from heat?

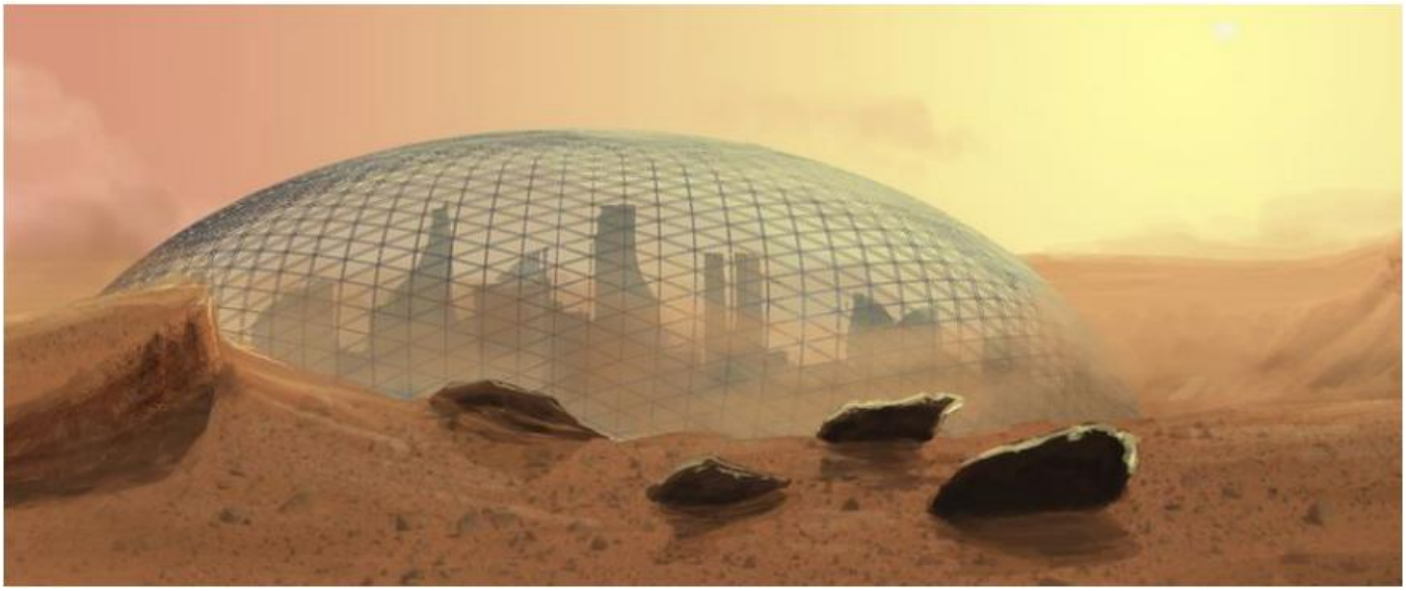


Food? Water? Shelter? Temperature?
STRENGTH? SUNLIGHT? AIR FLOW? BIODIVERSITY?

(9) Source: https://www.detail.de/blog-artikel/schier-unkaputtbar-biodome-das-haus-der-zukunft-29108/

BIODOMES OF THE FUTURE

Can you imagine a biodome on mars with robots to help humans grow plants? Where else could biodomes exist and how can they look like?



Don't forget to take photos of your biodome and tag:
@RIBALearning on Twitter and use the #ArchitectureAtHome

THANK YOU,
YOUNG ARCHITECTS!

(10) Source: https://www.deviantart.com/roccenere/art/martian-biodomes-360531115; credit: RocCenere