

Definition of species

3 definitions of species...

- ① Biological species: a group of organisms with similar morphological features, physiological features, biochemical features
- able to interbreed & produce fertile offsprings

- similar morphology
- similar physiology



- similar biochemical features



Definition of species

3 definitions of species...

- ① Biological species: a group of organisms with similar morphological features, physiological features, biochemical features
- able to interbreed & produce fertile offsprings

- similar morphology
- similar physiology



- similar biochemical features



fertile offspring

Definition of species

3 definitions of species...

Biological species: a group of organisms with similar morphological features,

Situation



you found a type of organism!

Problem? - have similar body shape

- you don't see them
reproducing with each
other!

why? - not mating season

- stressed due to
human presence

- we have not cut them open — we don't know
how their body function

- we have not analyzed their DNA — we don't know their
biochemical features

Definition of species

3 definitions of species...

② morphological species: a group of organisms that have similar morphological features

- we only use this definition when we discover a new type of organism



- we have not enough information on the physiological & biochemical features

- we have not seen them interbreed.

Situation



morphological species: a group of organisms that have similar morphological features

Definition of species

3 definitions of species...

Situation
These birds

- are in the same area
- eat same type of food
- have the same predators

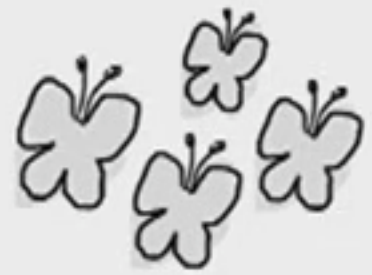
} we can assume the birds are the same species



③ Ecological species: a group of organisms living in the same area and have the same **niche** (their function in the environment)

Situation

Based on
ecological species
concept?
Different Species!

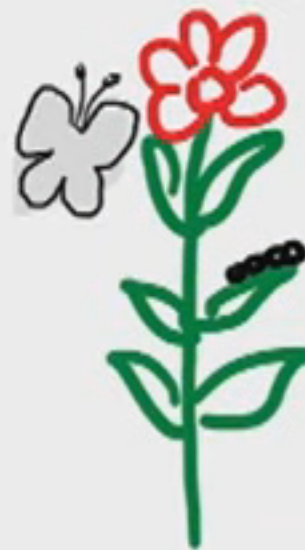


- caterpillars eat a particular plant
- food for small birds



- caterpillars eat tree leaves
- food for monkeys

} different ~~function~~
niche



These caterpillars
eats this
particular plant
only eaten by small birds



 These caterpillars
only eat the
leaves of trees
only eaten by monkeys!

- (b) Grizzly bears, *Ursus arctos horribilis*, and polar bears, *Ursus maritimus*, are found in North America.

Fig. 8.1 shows a grizzly bear and a polar bear.



grizzly bear



polar bear

Fig. 8.1

Grizzly bears have:

- a varied diet that includes grasses, roots, berries, nuts, rodents, insects and fish
- a habitat of woodland or grassland
- a maximum mass of 270 kg.

Polar bears have:

- a diet that consists of other animals, such as seals
- a habitat of land and sea ice
- a maximum mass of 450 kg.

Climate change has caused populations of grizzly bears to spread further north and populations of polar bears to spread further south. In some areas there is habitat overlap and, on rare occasions, breeding between grizzly bears and polar bears has occurred.

The offspring of grizzly bears and polar bears are known as pizzly bears.

Pizzly bears can breed together in the wild.

Fig. 8.2 shows a pizzly bear.



Fig. 8.2

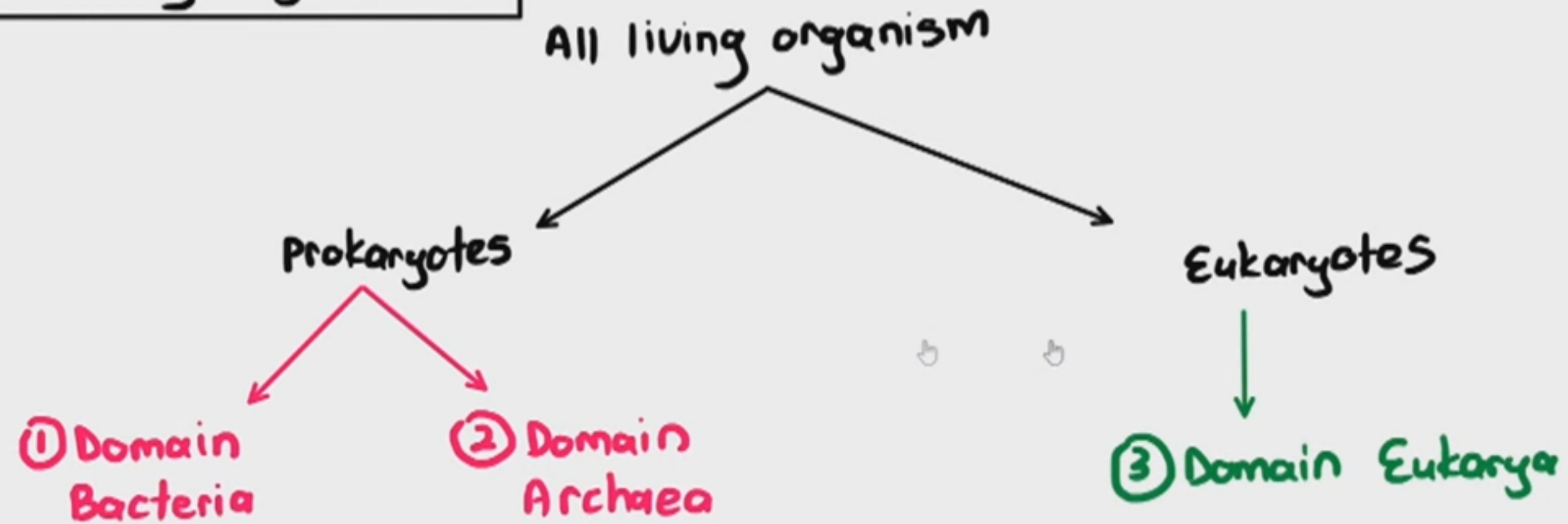
With reference to **three** different species concepts, discuss whether grizzly bears and polar bears should be classified as separate species.

Biological species: same species ①
definition/concept can interbreed & produce fertile pizzly bears ①

Morphological species: - different species ①
definition/concept - different fur color & max mass ①

Ecological species: - different species ①
definition/concept - different habitat & diet ①
so, they have different niches ①

Classification of ALL living organisms



	Domain Bacteria	Domain Archaea	Domain Eukarya
nucleus	✗	✗	✓
DNA	-circular -no histone proteins	-circular has histone proteins	-linear has histone proteins
Plasmids (very small circular DNA)	✓	✓	✗
membrane-bound organelles	✗	✗	✓ RER, SER, mito, chloroplast, GA....
cell wall	✓ peptidoglycan	✓ (not peptidoglycan)	in some... plants: cellulose fungi: chitin
Ribosomes	70s	70s	70s in mitochondria & chloroplast 80s in RER & cytoplasm have similar small subunits
cell division	binary fission (not mitosis)	binary fission (not mitosis)	mitosis
cell membrane	Phospholipid bilayer	Phospholipid monolayer	Phospholipid bilayer

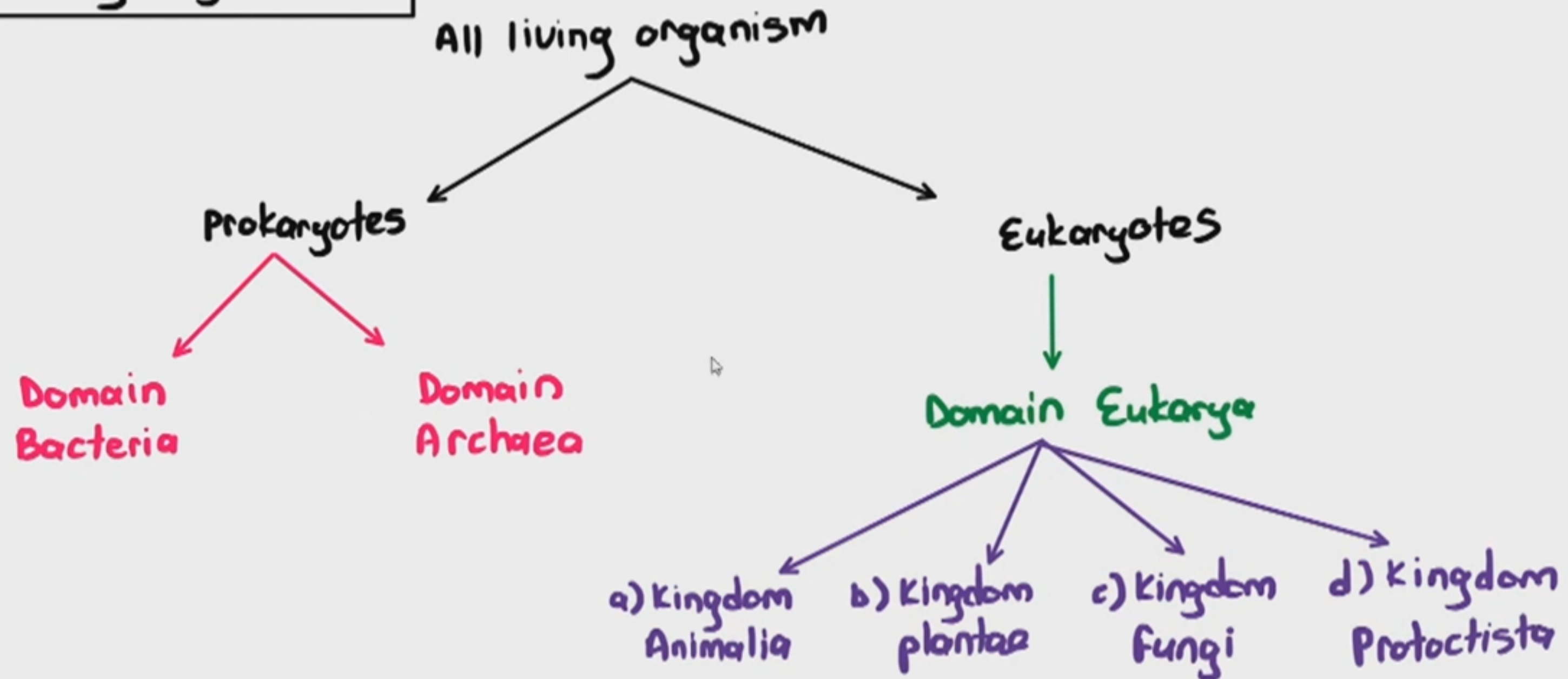


Bilayer



monolayer

Classification of ALL living organisms



Domain Eukarya

Eukaryotic?

unicellular or multicellular?

Tissues & organs?

chloroplasts

Nutrition

cell wall

vacuole

cilia or flagella

Kingdom Animalia	Kingdom Plantae	Kingdom Fungi	Kingdom Protista
✓	✓	✓	✓
multicellular specialized cells	multicellular specialized cells	unicellular or multicellular	mostly unicellular
✓	✓	✗	✗
✗	✓	✗	Some
Heterotrophic	Autotrophic (photosynthesis)	Heterotrophic	Autotrophic Heterotrophic
✗	cellulose cell wall	chitin cell wall	Some
small, temporary	large, permanent	////	////
in some cells	mostly absent	NONE	Some

✓ chloroplasts

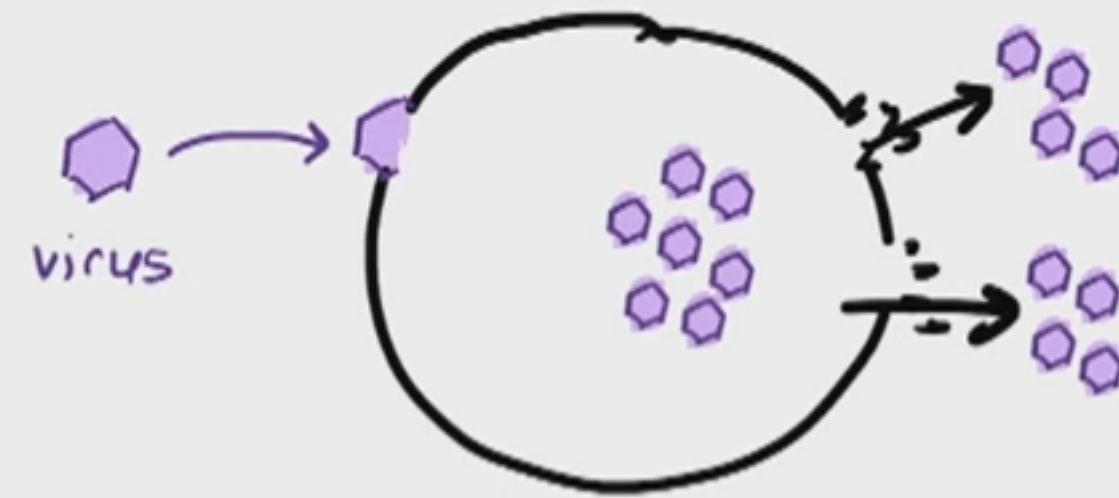
✗ chloroplasts

Viruses

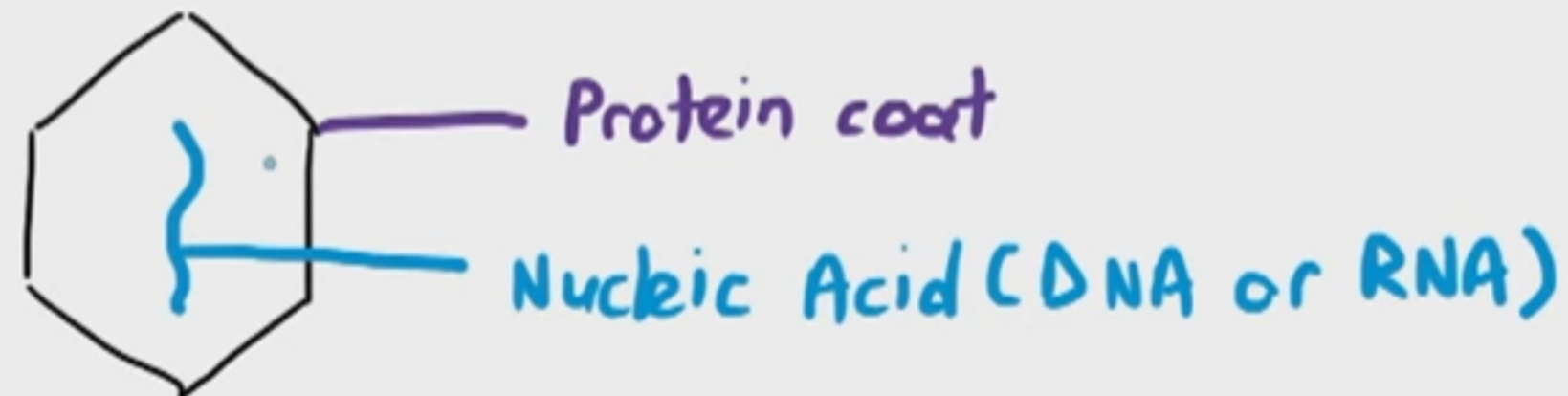
Revision

- Acellular (lack cell structures)
 - no cytoplasm
 - no ribosomes
 - no cell surface membrane

- Don't carry out living processes
 - Do not respire
 - Do not reproduce (have to enter host cells to replicate)

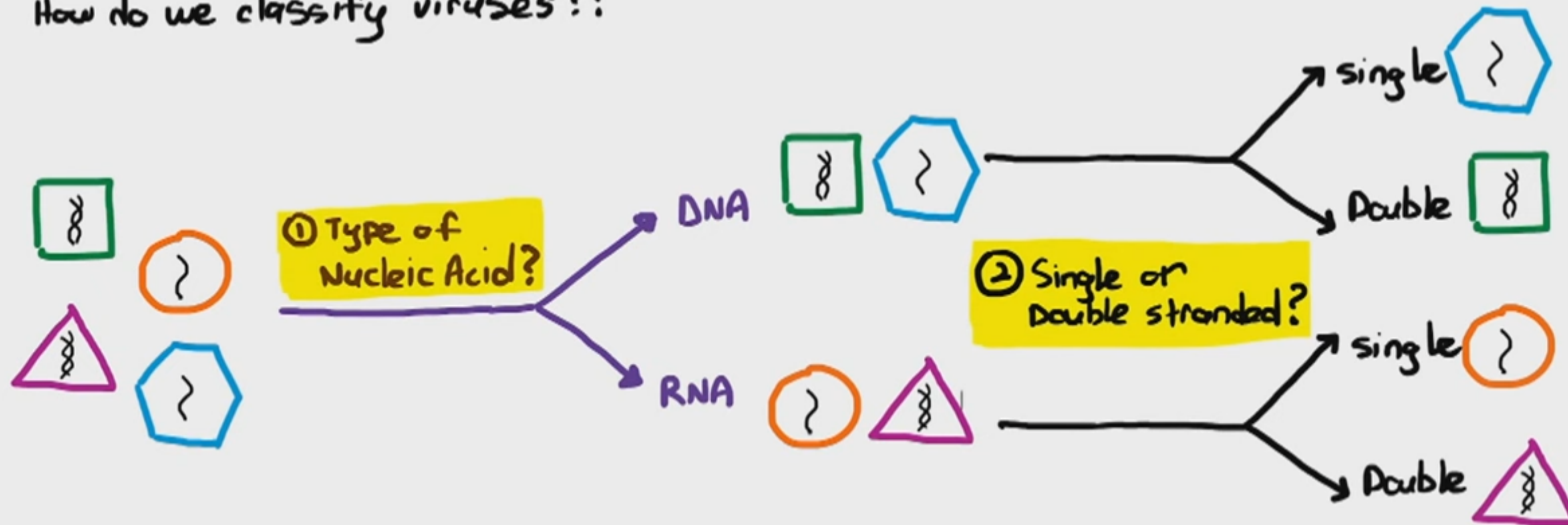


- Basic Structure



Viruses

How do we classify viruses??



in viruses, DNA & RNA can behave differently!!

Biodiversity

we define biodiversity in 3 levels

- the number/variety of ^{*}ecosystems or habitat

- the number and abundance of different species in one area
- the genetic variation within 1 species

Important Definitions

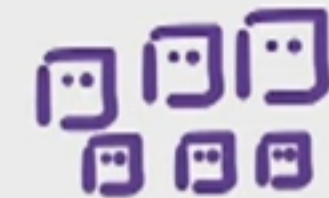
Population

- same species
- in same area
- at the same time



Habitat

- where the organisms live



→ Community

- All the different species in one area

→ Ecosystem ★★

- a self-contained unit containing the community and the environment



Biodiversity

we define biodiversity in 3 levels

- the number/variety of ecosystems or habitat

more habitat = more species



less habitat = less species.

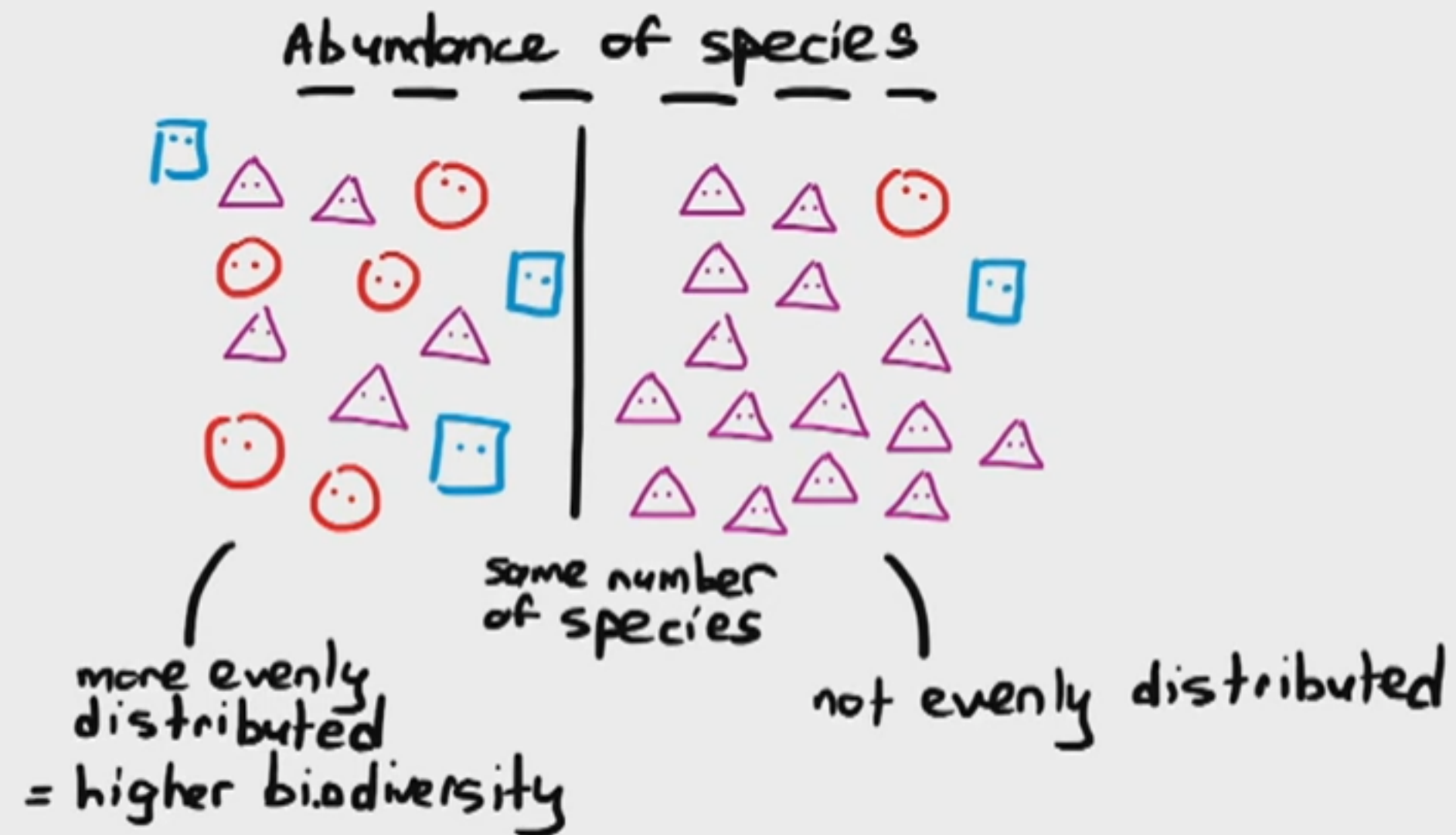
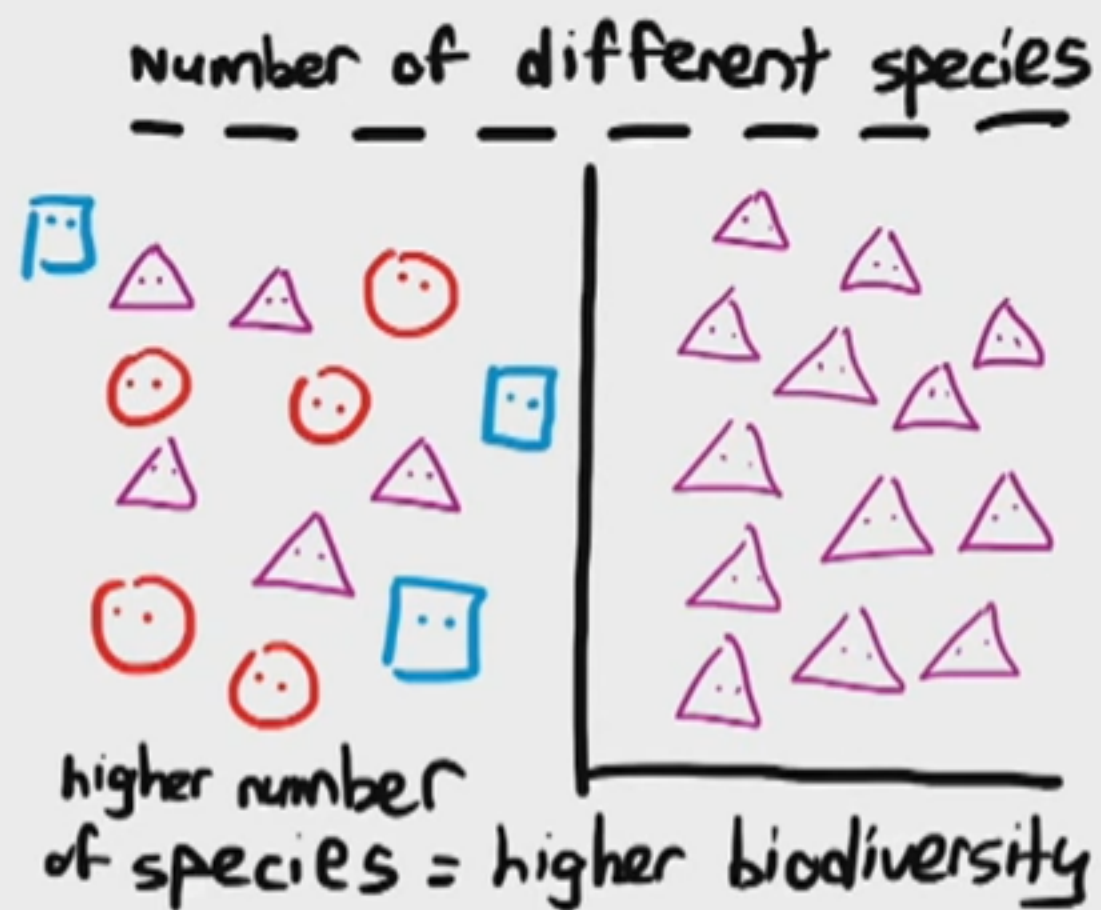


which one has a higher biodiversity?

Biodiversity

we define biodiversity in 3 levels

- the number and abundance of different species in one area



Biodiversity

we define biodiversity in 3 levels

- the genetic variation within 1 species

Species A



Species A



larger gene pool!

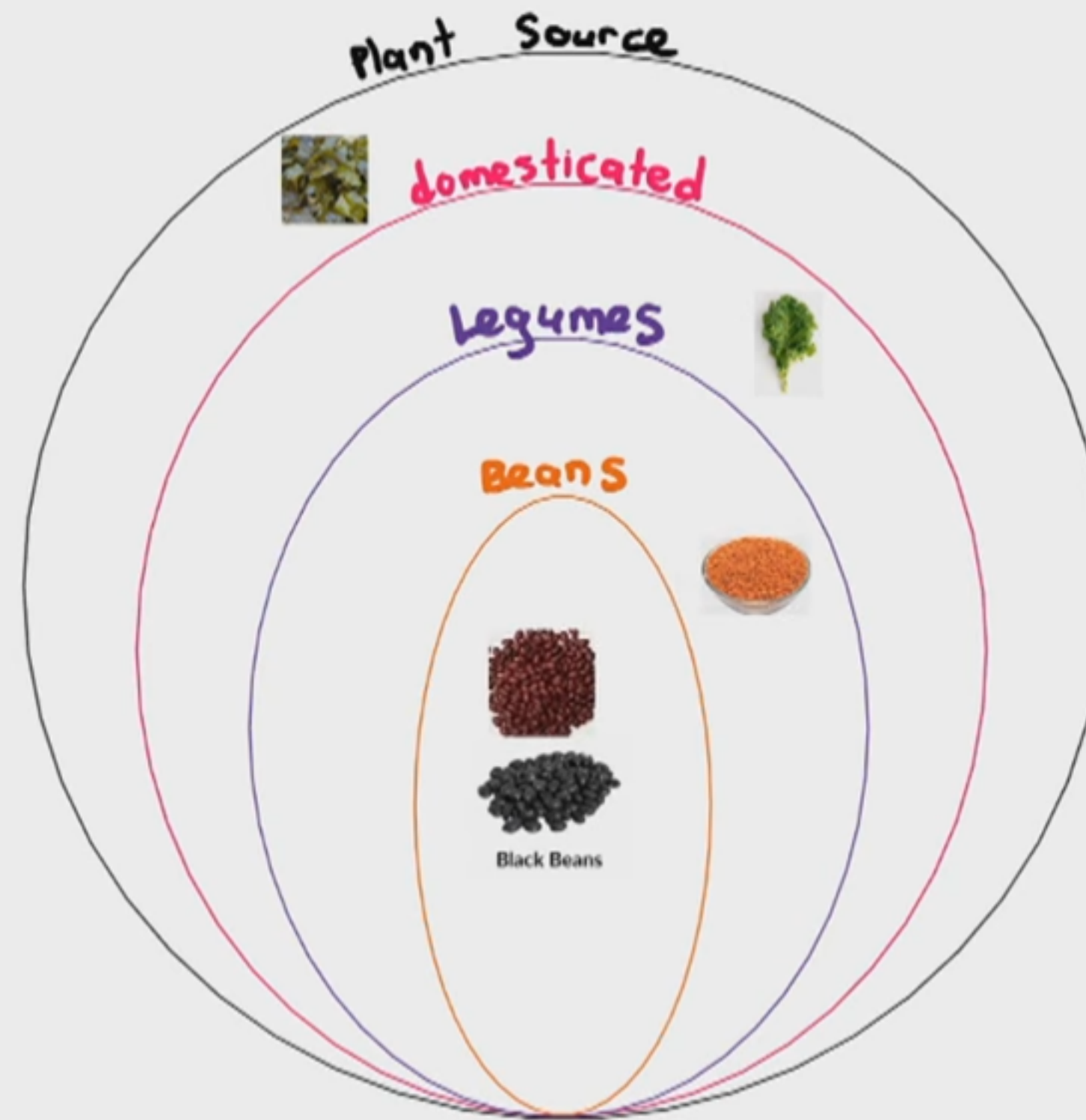
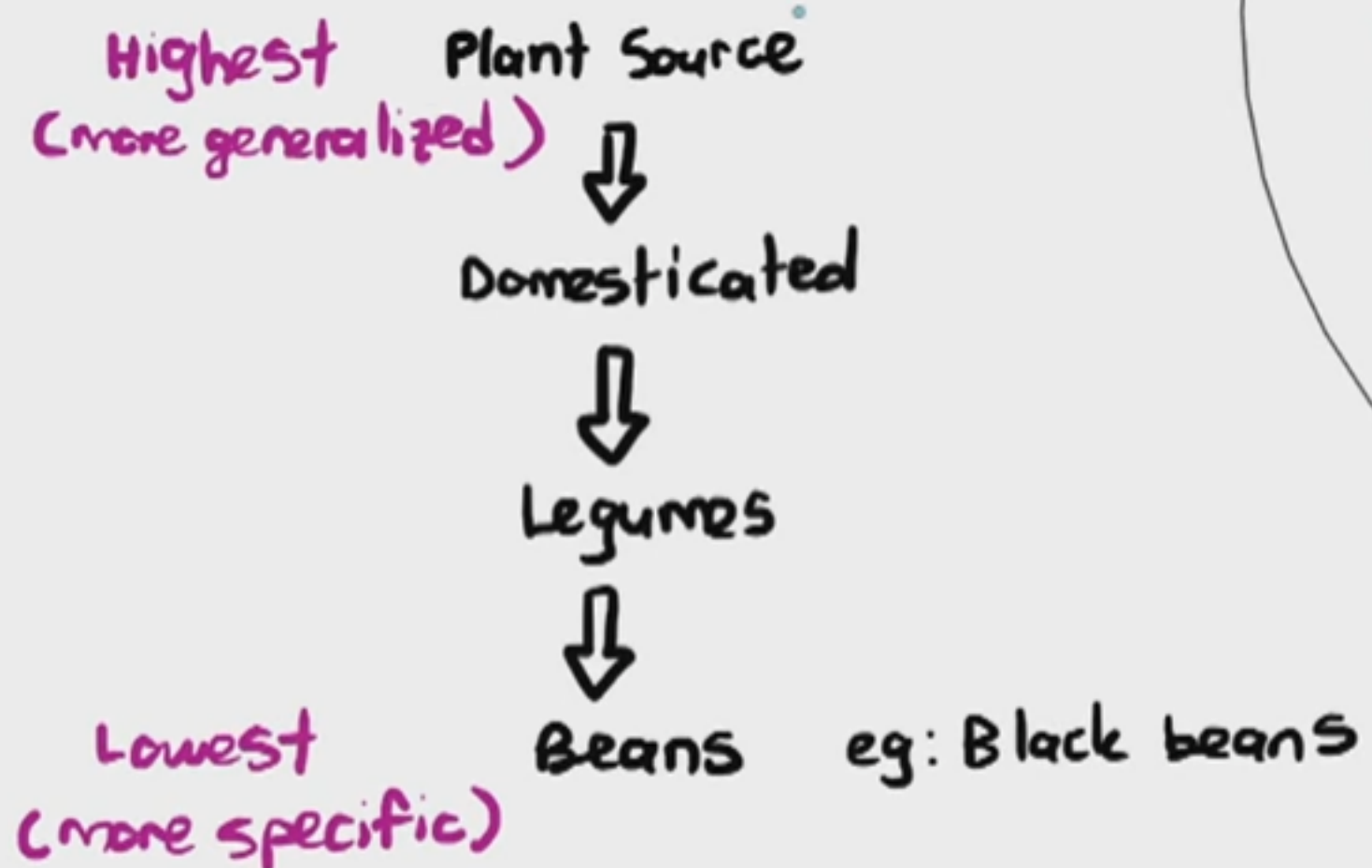
more genetic variation = more phenotypic variation!!

higher biodiversity!!!!

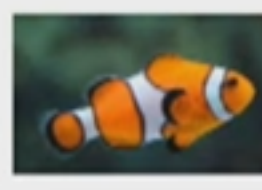
classification of organisms

Hierarchical classification

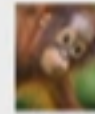
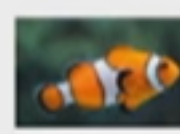
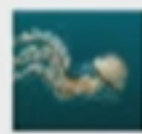
Based on levels
(Highest to lowest)



All living organisms

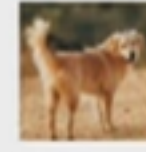
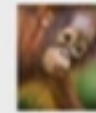
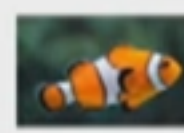


Domain



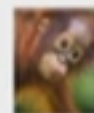
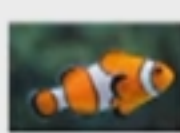
Eukarya

Kingdom



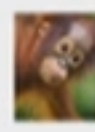
Animalia

Phylum



all have backbones

Class



all mammals

Order



carnivores



Family



cat family: felidae

Genus



usually large cats

species



meep?



meow?

measuring the number/abundance
of organisms in one area

situation

- calculate the number of
grass & ladybirds
in the entire field!!

we do **sampling**: we measure within
sections of the
entire habitat!!!



measuring the number/abundance
of organisms in one area

For Immobile/sessile organisms

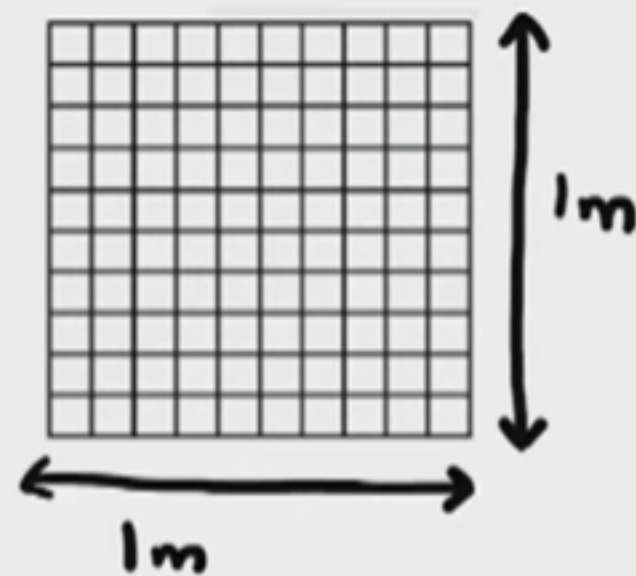
we do **quadrat sampling**

Quadrat

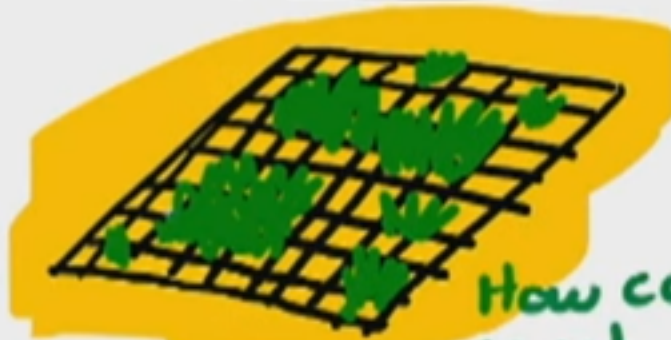
- square frame
with variable size



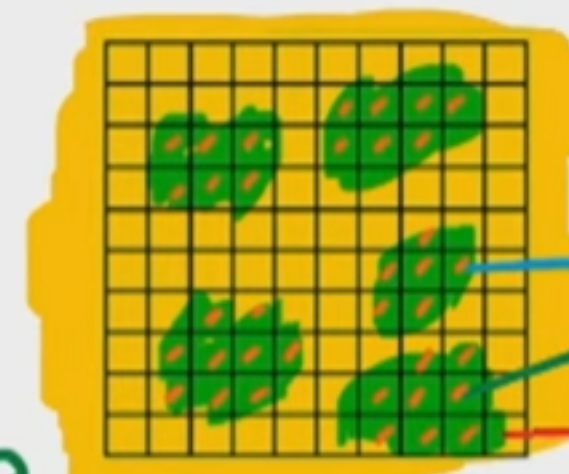
eg: 5 plants within 1m^2



Problem?



How can we
count grass?



Measure
percentage
distribution = 36%

✓ (more than half)

1%

x (less than
half)

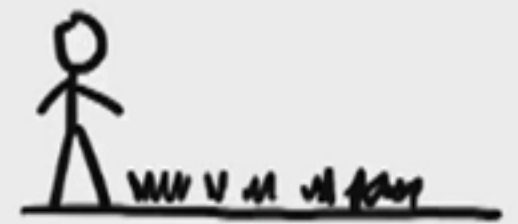
100 small grids = 100%

measuring the number/abundance
of organisms in one area

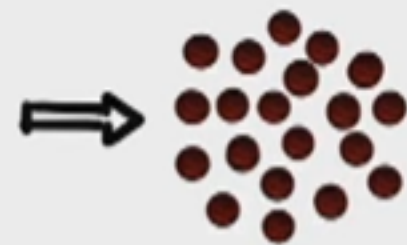
for mobile organisms

Lincoln Index: mark-release-recapture

eg: Ladybird population



capture as many
organisms as
possible



mark the organisms
→ must not harm them
→ must not increase/
decrease survival
chances



release it
& let them mix
with the general
population

recapture
after a
few days



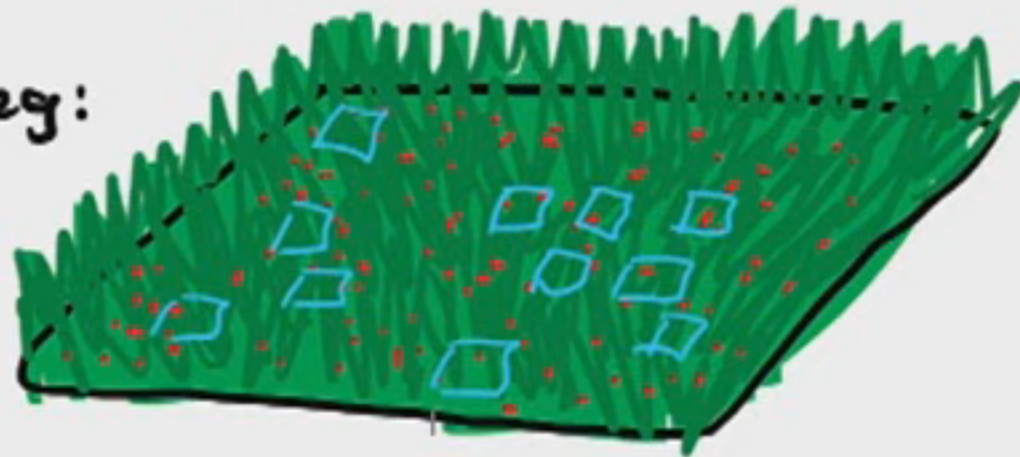
$$\begin{aligned}\text{Population size} &= \frac{\text{First capture} \times \text{Second capture}}{\text{number of marked individual in recapture}} \\ &= \frac{20 \times 23}{6} = 77\end{aligned}$$

method of sampling

Random sampling

- sampled areas are chosen randomly

eg:

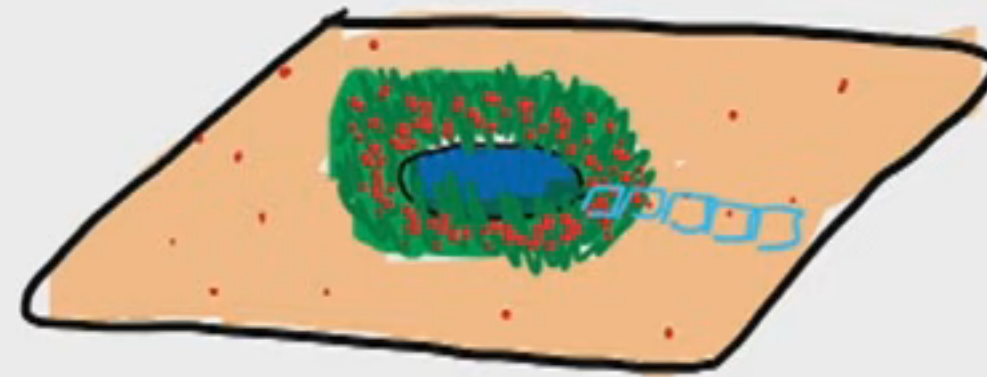


when is it done?

- area is uniform (no obvious differences in the area)
- no obvious pattern to species distribution (evenly spread out)

Systematic sampling

- sampled areas are chosen non-randomly



when is it done?

- the area is not uniform
- there is an obvious pattern in species distribution

method of sampling

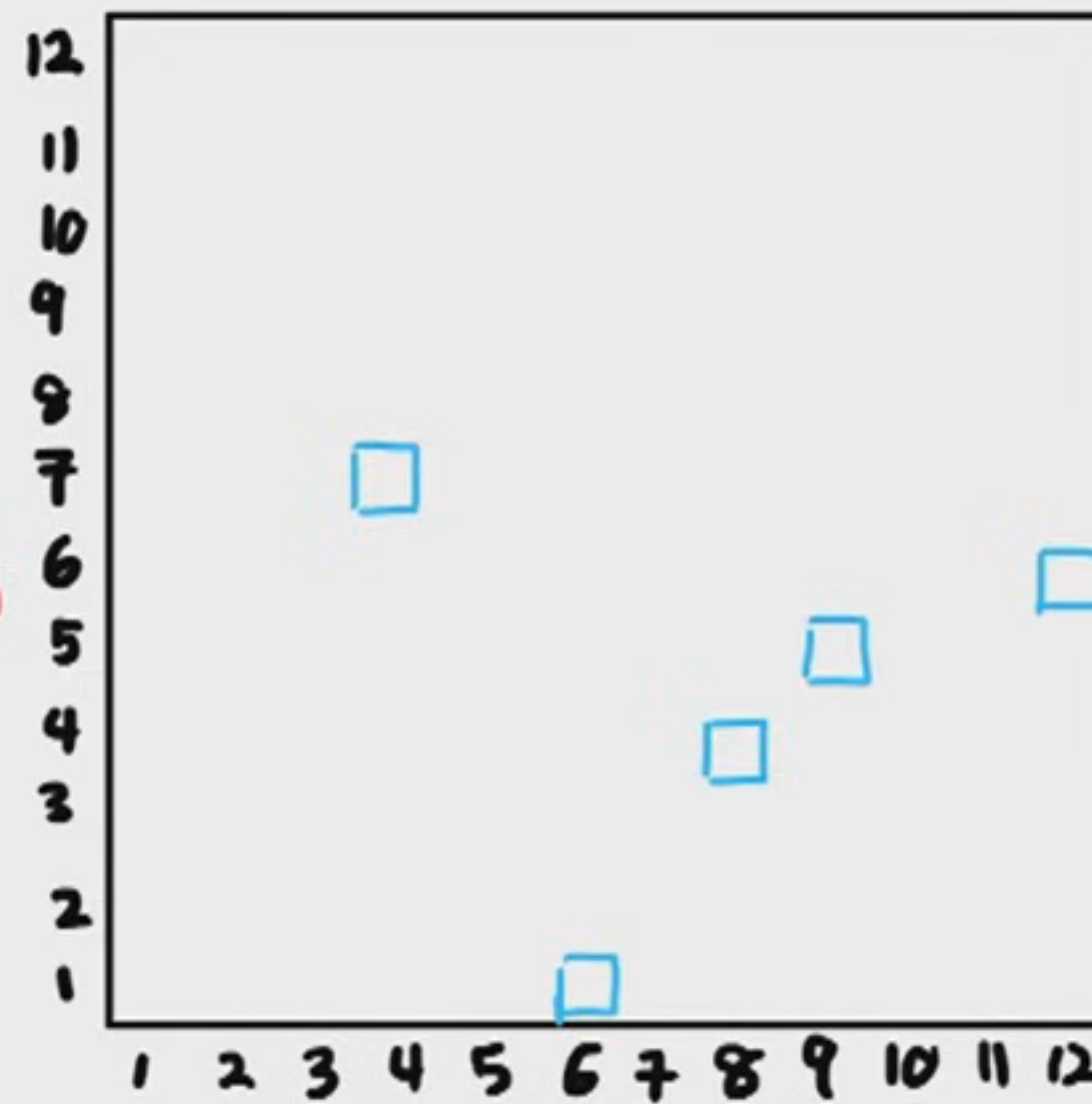
Random sampling

How do we place the quadrats randomly?

- we divide the area using coordinates
- use RNG (random number generators) to generate a coordinate

at least 10 quadrats for reliability

Field



method of sampling

Systematic sampling

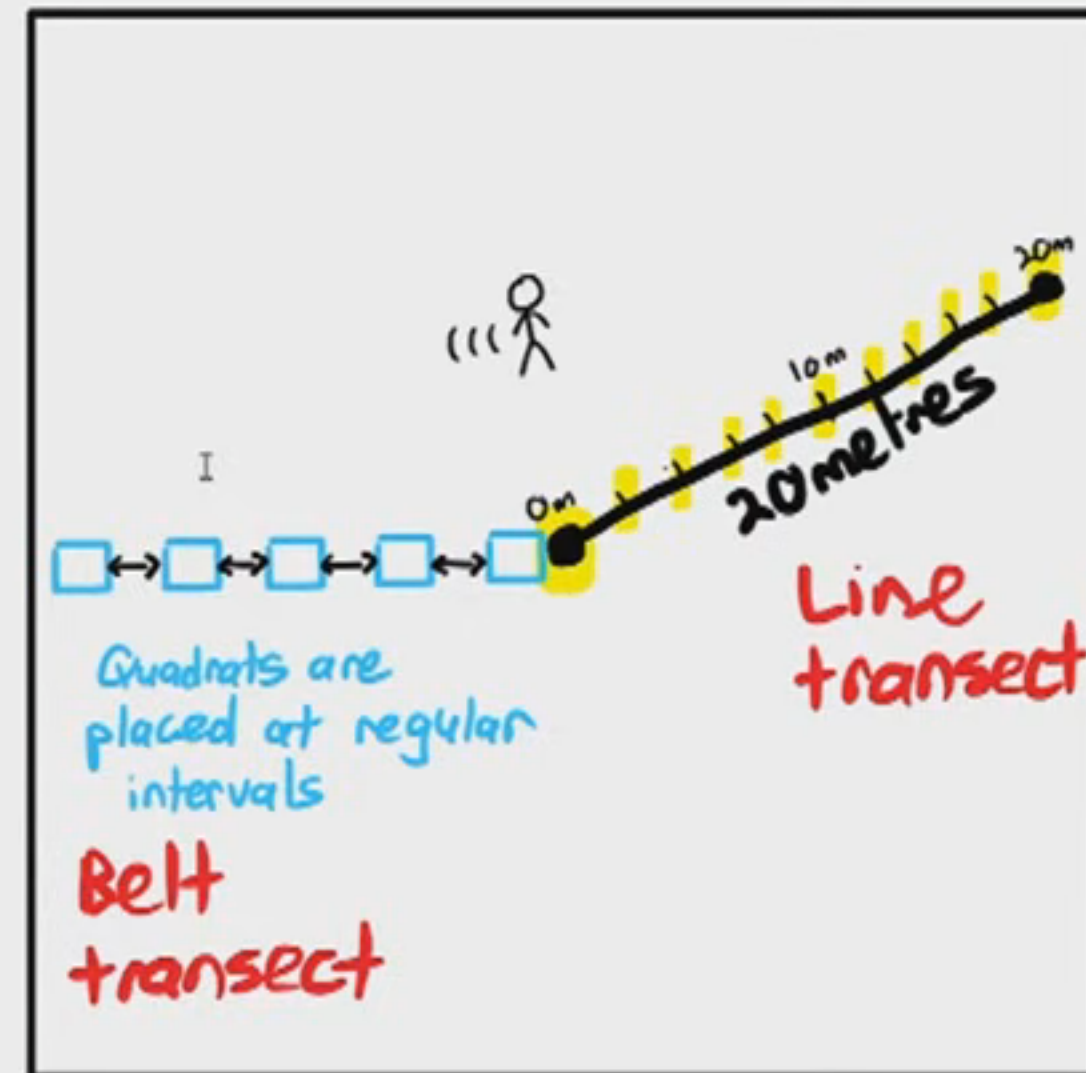
a) Line transect

- identify any species that touches the line at specific intervals

b) Belt transect

- Place the quadrats at regular intervals.

Field



Simpson's Index of Diversity

- calculates the biodiversity → number of different species & their abundance in 1 habitat

$$D = 1 - \left(\sum \left(\frac{n}{N} \right)^2 \right)$$

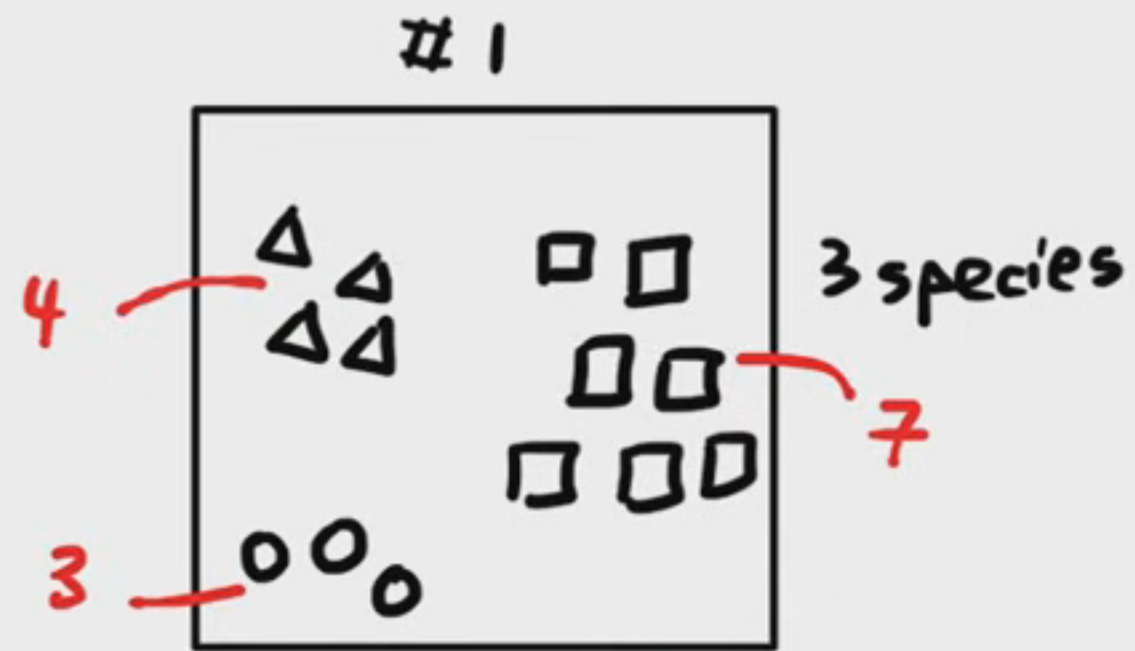
(0 to 1)

low biodiversity → high biodiversity

total number of organisms in 1 species

total number of organisms of all species

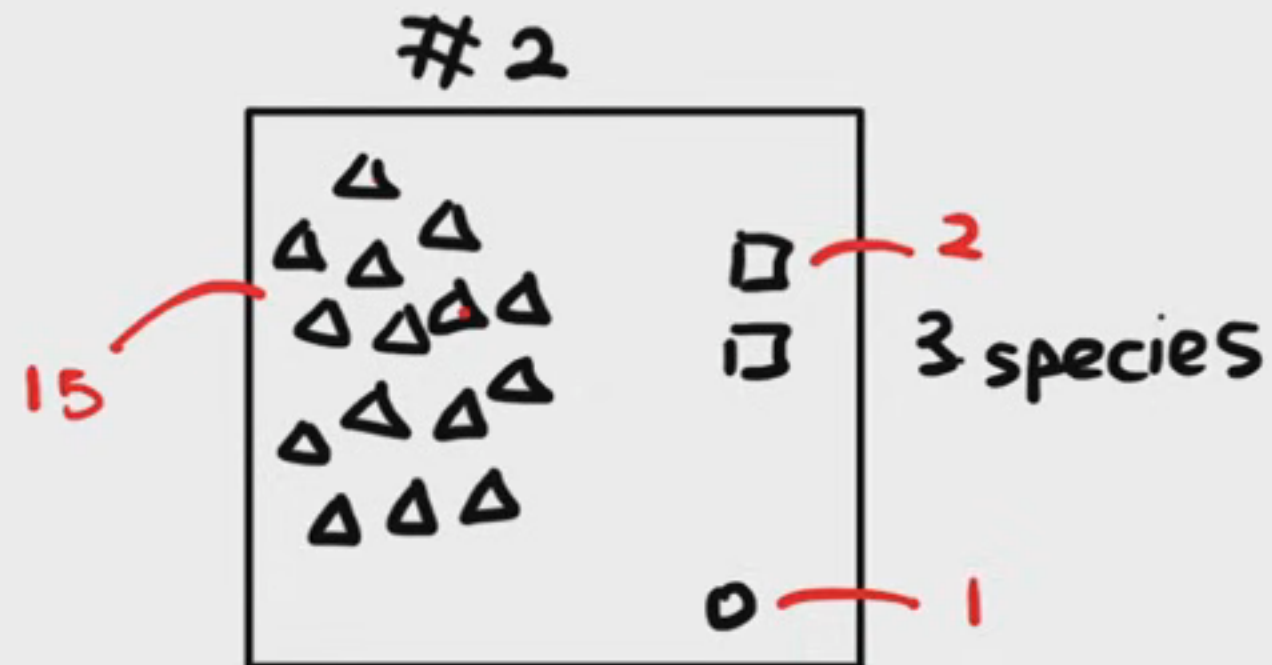
In my example



$$D = 1 - \left(\left(\frac{4}{14} \right)^2 + \left(\frac{3}{14} \right)^2 + \left(\frac{7}{14} \right)^2 \right)$$

$$= 1 - 0.38$$

$$= 0.62 \text{ (higher biodiversity)}$$



$$D = 1 - \left(\left(\frac{15}{18} \right)^2 + \left(\frac{2}{18} \right)^2 + \left(\frac{1}{18} \right)^2 \right)$$

$$= 1 - 0.71$$

$$= 0.29 \text{ (lower biodiversity)}$$

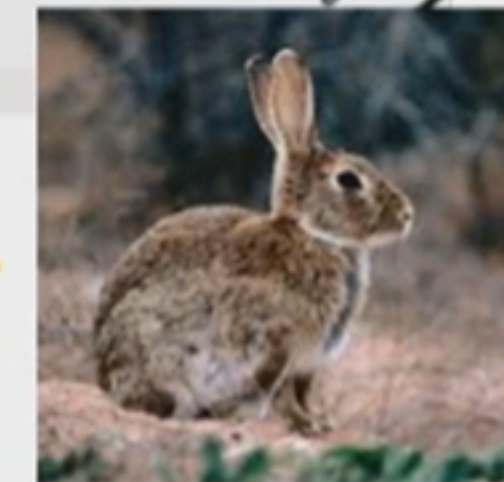
Conservation

- protection & maintenance of biodiversity

Extinction & Endangered species

what causes this to happen?

- a) Excessive hunting by humans
- b) loss of habitat
- c) climate change — unable to adapt to changing environment
- d) Alien species :- a species that moves into a new area & competes with the local species
or
Invasive species



Conservation

why do we have to protect & maintain biodiversity?

① moral & ethical reason:- we are aware of the damage we do
so we have a responsibility to reduce it

② Economic reason:
→ Plants are source of drugs/medicine & gene tech
→ ecotourism: national parks, coral reef

③ Environmental reasons
→ Forests absorb CO_2 to reduce greenhouse effect
→ Transpiration from trees humidify the air

④ Aesthetic/Beauty reasons
→ source of inspiration for artists

⑤ Ecological reason: - to protect food chains & food webs

Methods of conservation

① National Parks

what is it?

- areas protected by government / country
- no large scale buildings or industrial activities

what do they do?

- a) protection of habitat / ecosystem
- b) ecotourism
- c) Reduce damage caused by human activities.



Methods of conservation

2) Zoos

a) what is it?

- a place that houses animals of various species



b) what do they do?

- ecotourism
- protection of endangered species
- research/study their behaviour
- education to raise awareness

diet

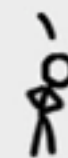
breeding habits

habitat requirement

} to be able to reintroduce back into the wild!!

• breeding programs - Frozen zoos, Artificial insemination, In-vitro fertilization

what do you need?



Fish!!



Psst! Ask for a nice river too!!!

Methods of conservation

③ Botanic Gardens

They are like zoos, but for plants!!

a) what do they do?

- ecotourism
- protection of endangered species
- research/study their behaviour
- education to raise awareness
- breeding programs



mineral requirement
& soil type
breeding habits

} to be
able to
reintroduce
back into
the wild!!

Methods of conservation

④ Seed Banks

a) what is it?

* a place where plant seeds are stored to conserve the biodiversity

b) what do they do?

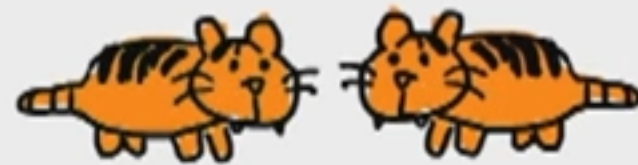
- storage of seeds in a cool, dry area
- collection of seeds from many different species
- collection of seeds from different varieties within 1 species!!

c) Limitations

- some plants have seeds that cannot be dried & stored
- eg: rubber trees.

Assisted Reproduction

Problems.....



Tiger population
is very low...

captured
⇒



expected to reproduce
(captive breeding)

not closely
related,
so, no
inbreeding
depression
happens



Problem # 1

* The 2 tigers may
not reproduce with
each other!!

↙ not attracted ↘ due to stress

Problem # 2

- breeding closely
related animals
may lead to
inbreeding depression

Problem # 3

- expensive & difficult
to transport
animals between
different zoos!!

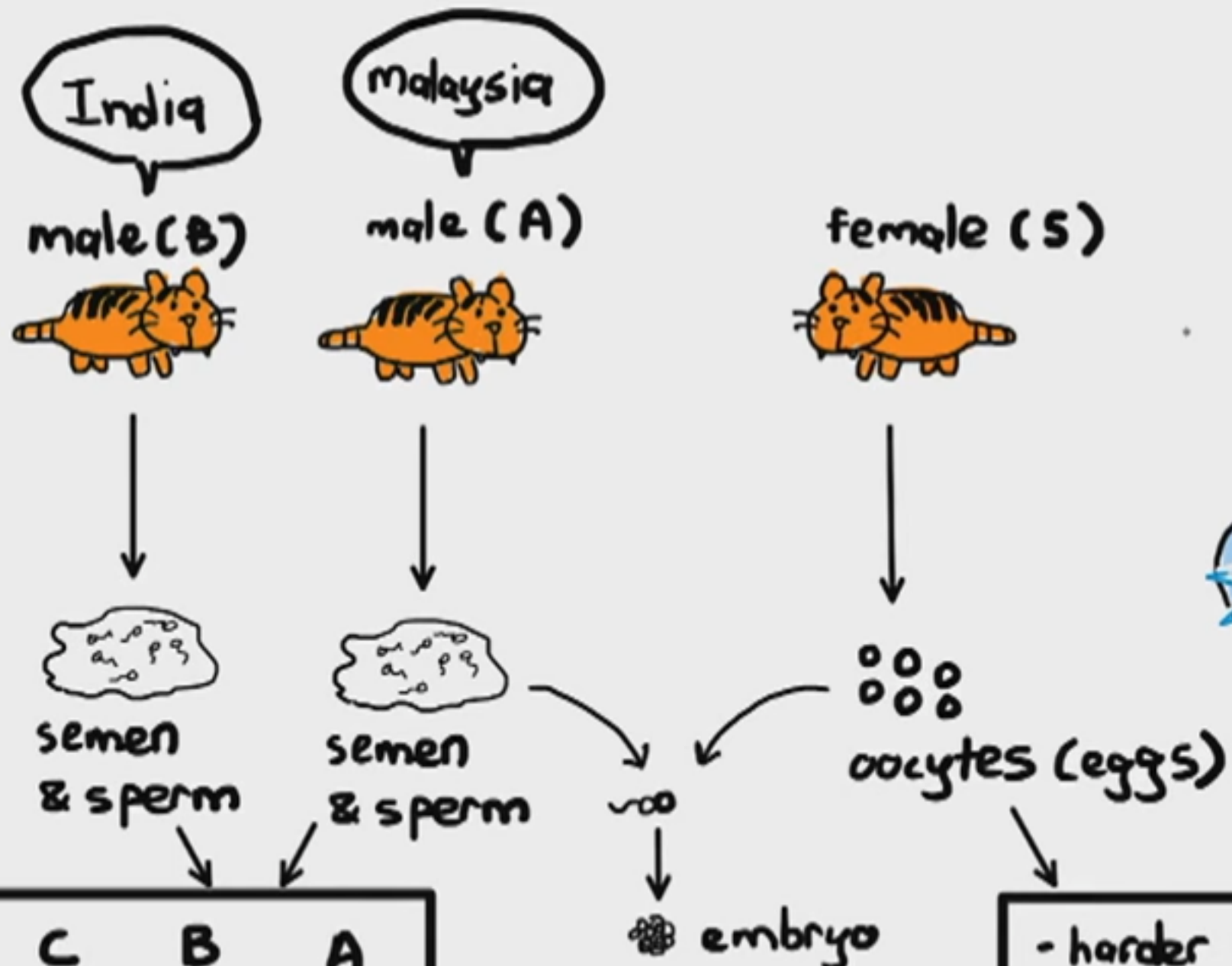
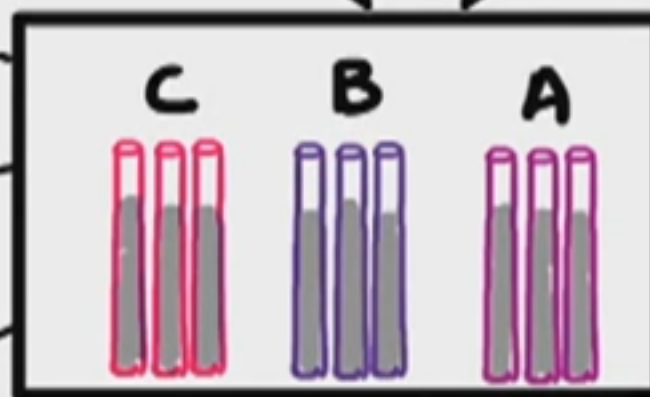
Assisted Reproduction

① Frozen zoos

- facility that stores **genetic material** from animals at around **-196°C**

store sperm from many varieties of animals
less storage space required
Health history & traits are recorded

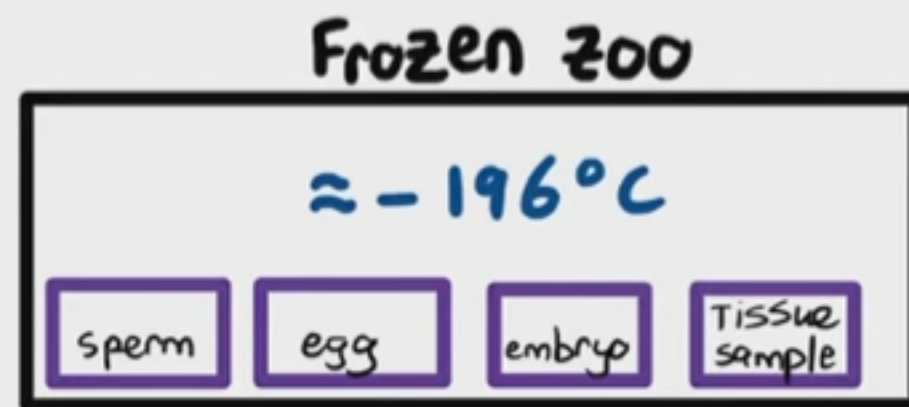
kept in straws & frozen



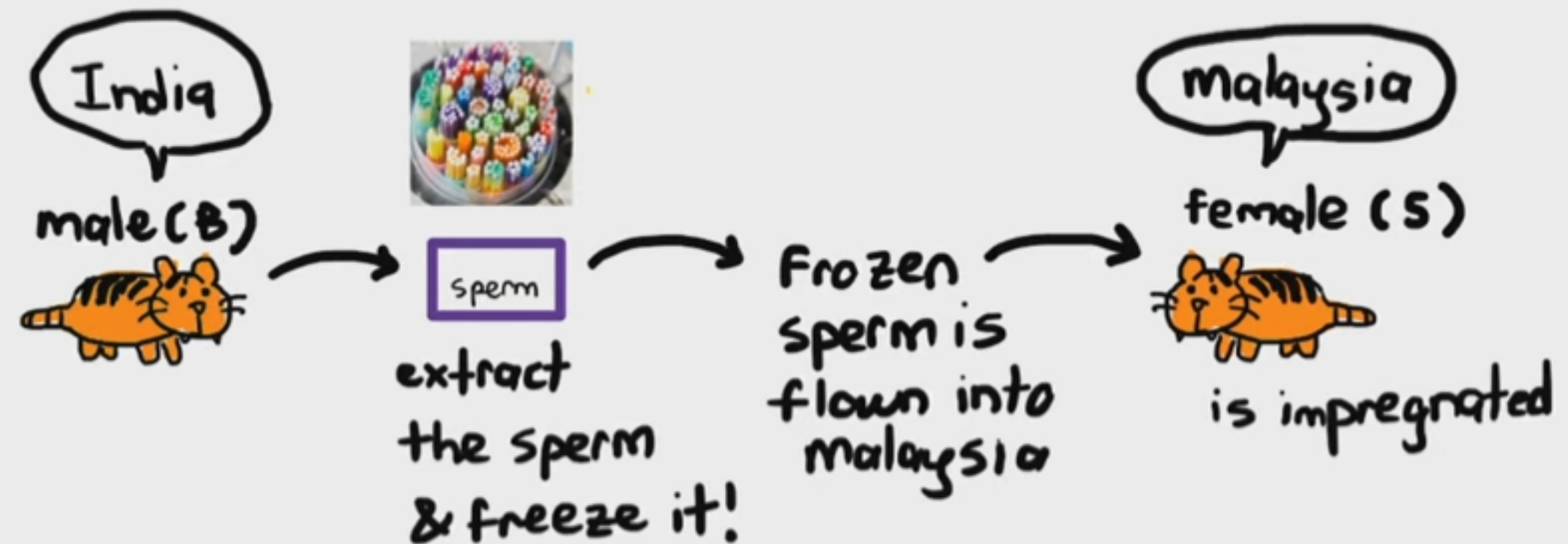
- harder to freeze eggs
- higher H_2O content may cause it to **crystallize** leading to damage

Assisted Reproduction

so, how can frozen zoos help?



a) Portable storage of many different species genetic information



b) Cheaper & easier transport of genetic material

c) Prevents inbreeding depression!!

Assisted Reproduction

② Artificial insemination

when do we use this technique?

→ when the male & female do not want to naturally breed

male



→ extract the sperm from male

female(s)



sperm is injected directly into the uterus through the vagina

get a frozen sperm sample from frozen zoo → Thaw

female

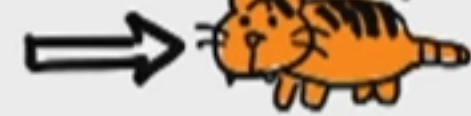


female(1) female(4) female(v)



embryos are removed & put into surrogate mothers (can be closely related species too...)

↑ or ...



female produces embryos



offspring is produced!!

eg:



male zebra

→ extract the sperm from male

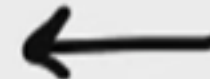
sperm is injected directly into the uterus through the vagina



female zebra



embryos are removed & implanted into surrogate mothers!



more zebras are produced !!

zebra embryos are implanted into horses!!!

Assisted Reproduction

③ In-vitro Fertilization

outside the female's body

Fusion of gamete nuclei

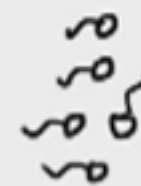


embryos are implanted into surrogate mothers

male

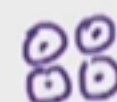


extract the sperm from the male or get it from Frozen Zoo



given fertility hormones to produce eggs

extract the eggs by inserting a needle into the ovaries



Fertilized in a petri dish....



multiple embryos are formed

embryos are stored in a Frozen Zoo