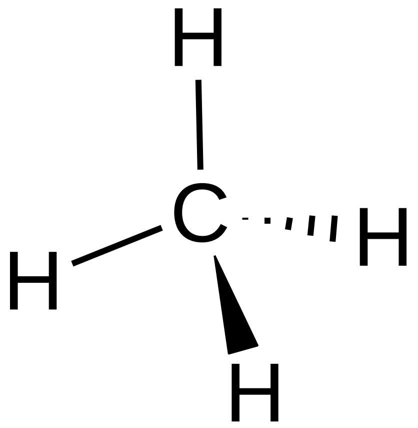
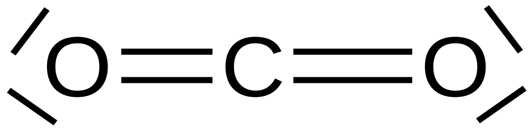
Biogas production

Via fermenter

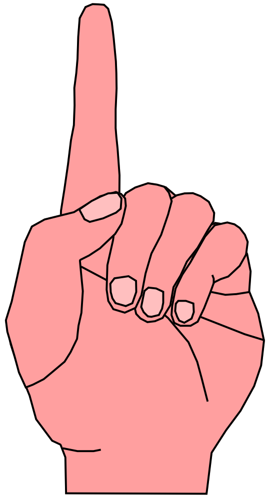
What is biogas?

- Biogas is a mixture of CO_2 and CH_4
- Only CH_4 is suitable for energy production, biogas should contain at least 50% of it.
- It is produced out of biomass eg. fruits or corn





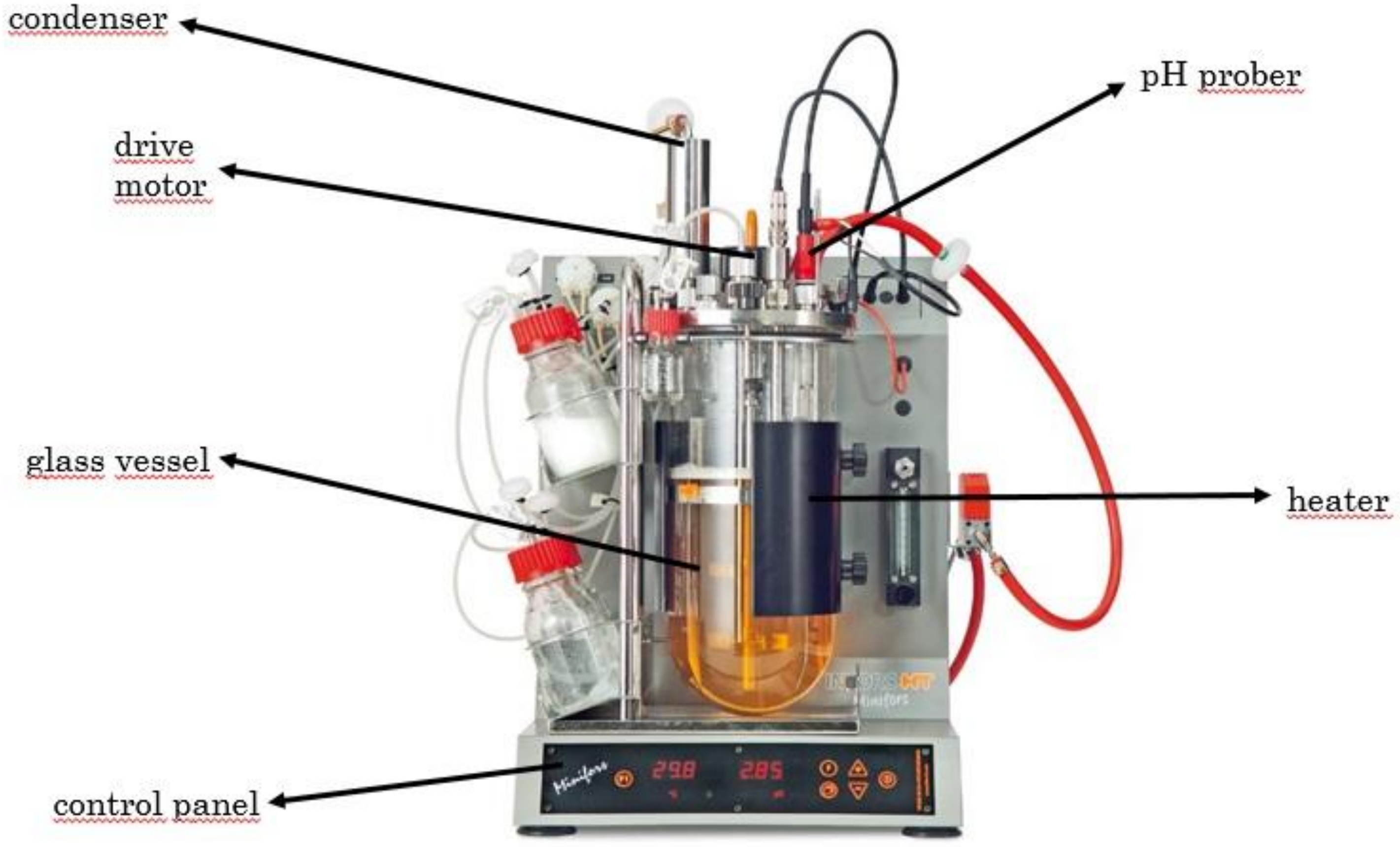
Attention!



- The biogas production only takes place under anaerob conditions, that means the fermenter has to be sealed **gas-proof!**
- $C_6H_{12}O_6 \rightarrow 3\ CH_4 + 3\ CO_2$

Fermenters in general

- Fermentor = vessel where is the substrate processed with the help of various microorganisms



Why do we do this?

- We want to determine perfect conditions to produce biogas:

 - optimal pH-value

 - best temperature

 - (most efficient stirring speed)

Fermentation

1. Fermentation

1.1 Filling till 90%

- Pour the glucose (10g/l) to the vessel so that the concentration in the substrate in the beginning of the fermentation amounts 10 g/l.

Video 1

1. Fermentation

1.1 Filling till 90%

- Fill 90% of the fermenter with the inoculum.

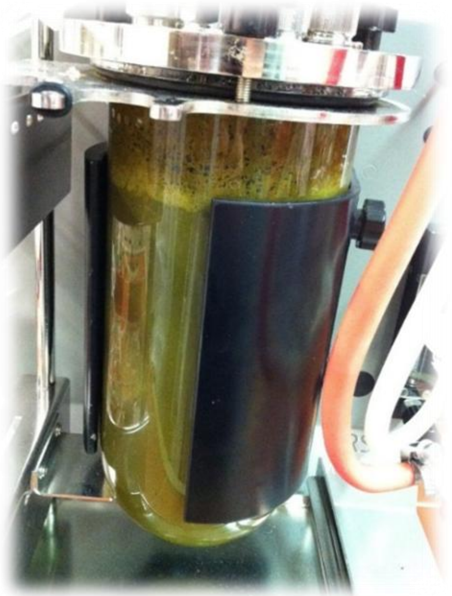
Dividing groups:

Groups 1-7:

Biology room (Thuc + Helena)

Groups 8-14:

Biology prep (Nana + Terezie)



1. Fermentation

1.1 Filling till 90%

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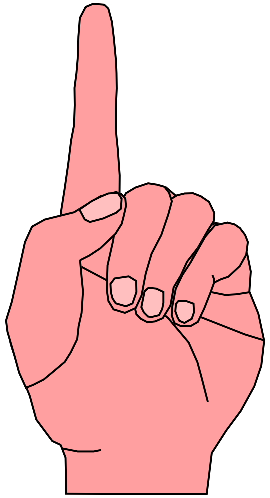
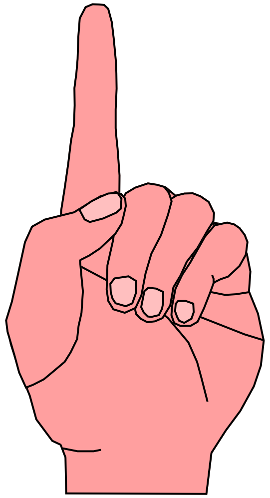


Remember to mix everything!

1. Fermentation

1.2 Gas-proof?!

- Make sure you mixed everything



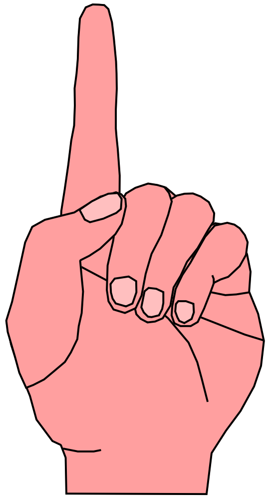
Make sure the fermenter is **closed** and check if it’s **gas-proof.**

- The inocolum consists of corn with living microorganisms.

1. Fermentation

Parameters

- Temperature: **50 °C**
- Rotation speed: **200 rpm**



Attention! The heater must be **under the water** and should **never touch the walls** of the bucket or vessel!

1. Fermentation

Video 2

Task 1:

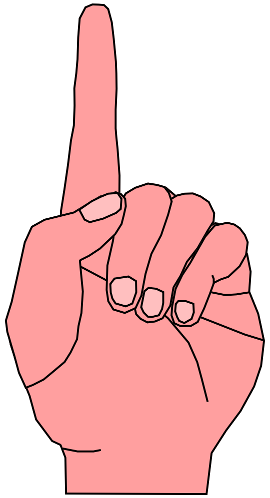
- Measure the concentration of glucose every 90 minutes

$$t_0, t_{90}, t_{180}, t_{270}$$

(By glucose determination)

Don’t forget to **take notes** all the time!

Reminder!



Wash your hands

everytime you leave this room!

2. Quantitative determination of biogas

2.1 Gas syringe

- Link the gas syringe to the fermenter and check if it’s gas-proof (pull the „Kolben“)

2. Quantitative determination of biogas

2.1 Gas syringe

Task 2:

Read the amount of the produced gas from the scale of the glass syringe. Do this every 30 minutes and represent the production rate in a graph.

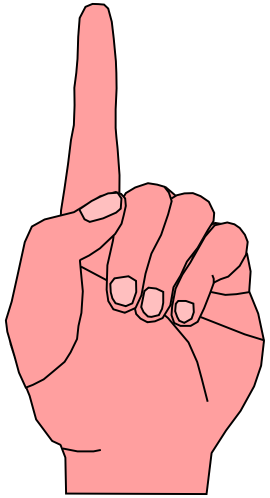
3. Qualitative determination of biogas

3.1 Flammable?

Task 3:

Test the ability to burn of the produced gas by using a syringe to put it into a flame

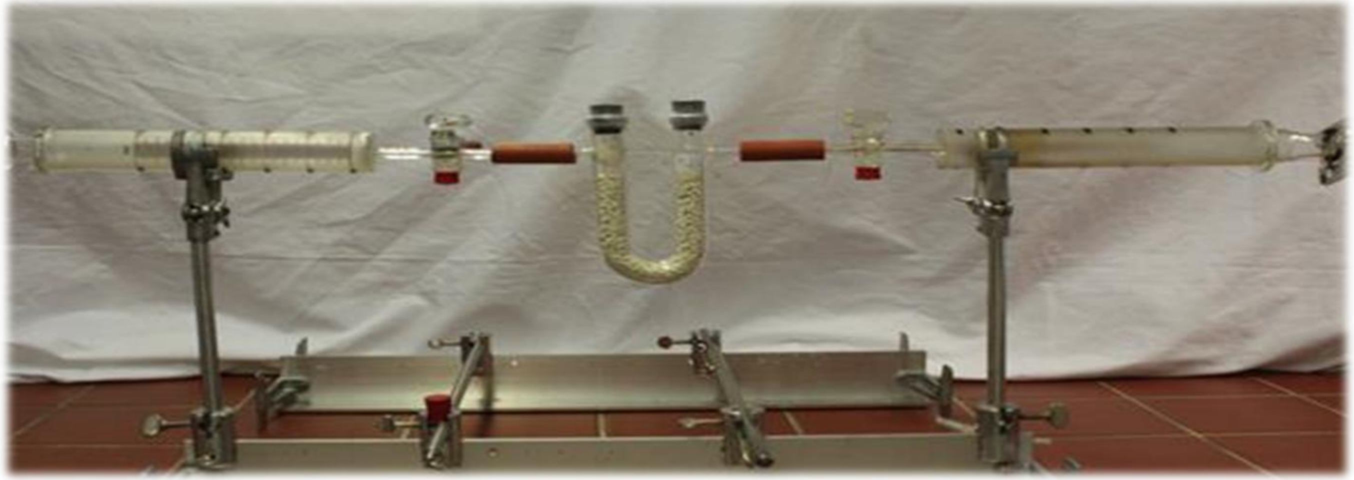
Reminder!



At least one person has to watch out for the fermenter!

3. Qualitative determination of biogas

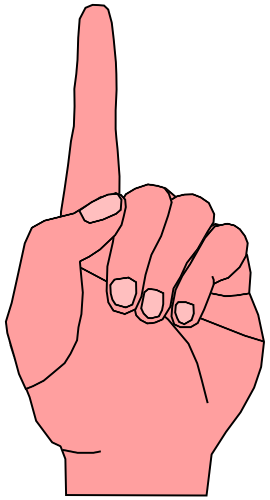
3.2 Chemical reaction of CO_2 with a mixture of NaOH and $Ca(OH)_2$



Task 4:

Fill 100ml of the biogas slowly through the U-pipe 3-5 times until the volume stays constant. Now read the amount of the chemical bound CO_2 from the scale of the glass syringe

Attention!



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3. Qualitative determination of biogas

3.2 Chemical reaction of CO_2 with a mixture of NaOH and $Ca(OH)_2$

Task 5:

Complete the following reactions:

2 NaOH + CO_2 → $Na_2CO_3 + H_20$

$Ca(OH)_2 + CO_2$ → $CaCO_3 + H_2O$

3. Qualitative determination of biogas

3.3 Gas chromatography

Task 6:

Inject 0,5 ml of the produced bio-gas mixture in the gas chromatograph and analyse the chromatogram.

GC-separation conditions are:

- Mobile phase: Helium
- Stationary phase: Silicon oil (non polar)

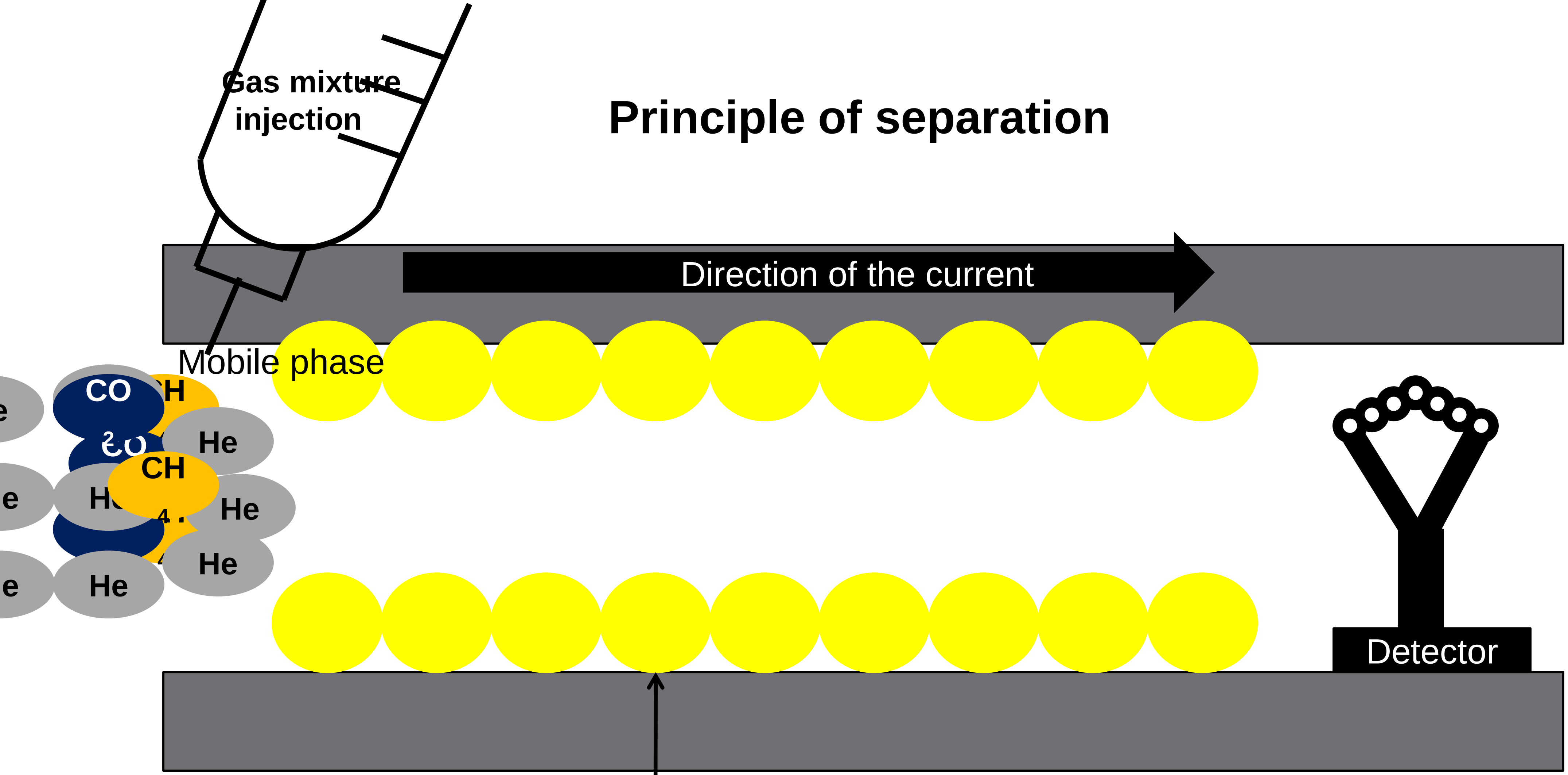
3. Qualitative determination of biogas

3.3 Gas chromatography

Dividing groups:

- **Groups 1-7:**
  - **GC on the left side**
- **Groups 8-14:**
  - **GC on the right side**

Principle of separation



Silicon oil as unpolar stationary phase

Why does CH_4 have shorter retention time?

Helium – mobile phase

Why does CO_2 have longer retention time?

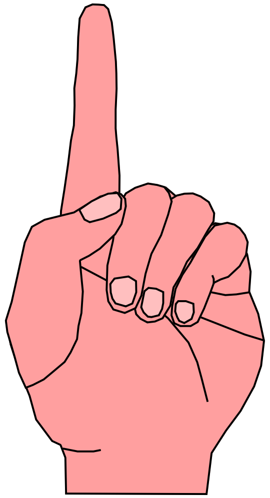
3. Qualitative determination of biogas

3.3 Gas chromatography

Task 7:

Match the retention times of the gases (CH_4, N_2, CO_2) with the peaks of the chromatogram regarding to the substance properties.

Reminder!



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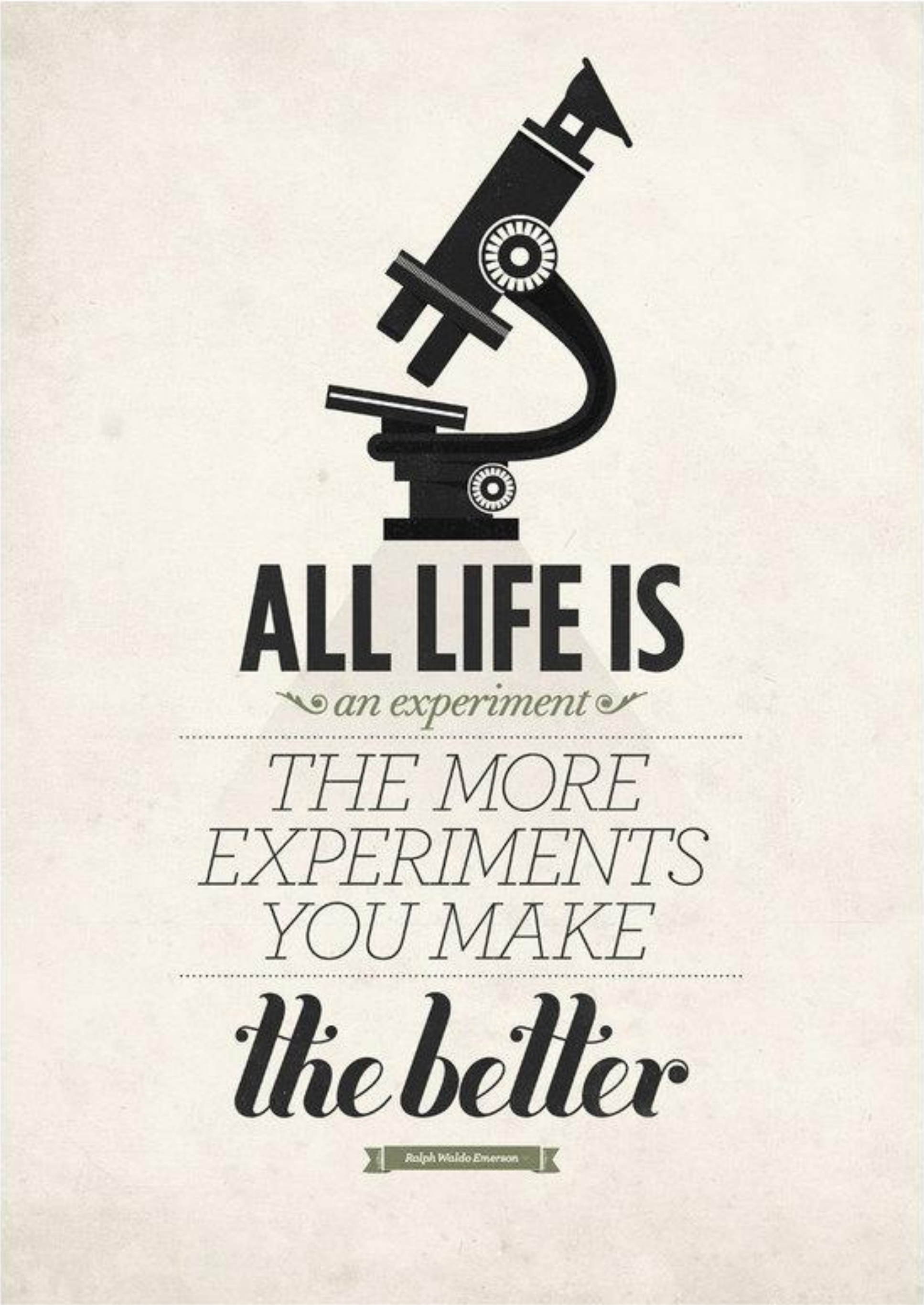
ALL LIFE IS
an experiment
THE MORE
EXPERIMENTS
YOU MAKE
the better
Ralph Waldo Emerson