MODUL KULIAH

IPA DASAR (BASIC SCIENCE)

Dosen :

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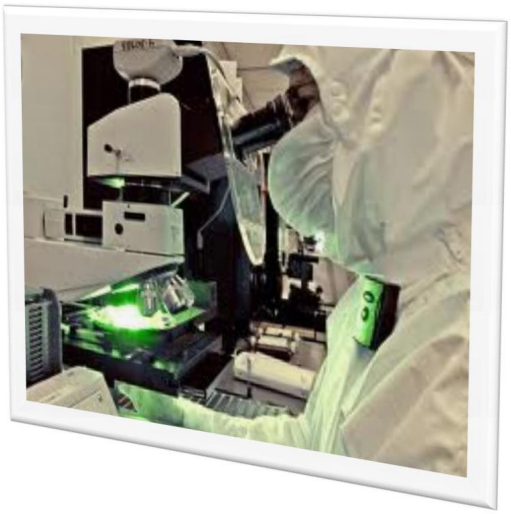
JURUSAN PENDIDIKAN IPA

FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM

UNIVERSITAS NEGERI YOGYAKARTA

2017/2018

How does
Science Work?

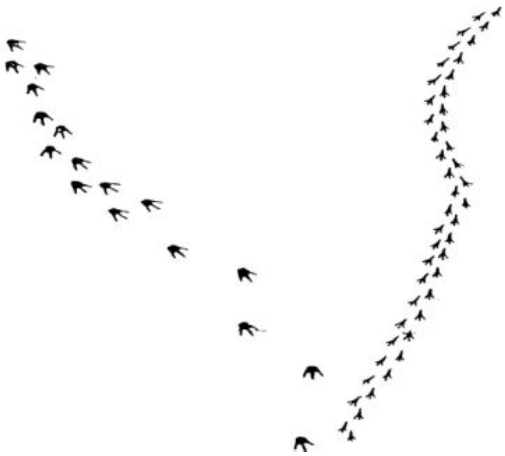


Presented by :
Sabar Nurohman, M.Pd

What did you observe?

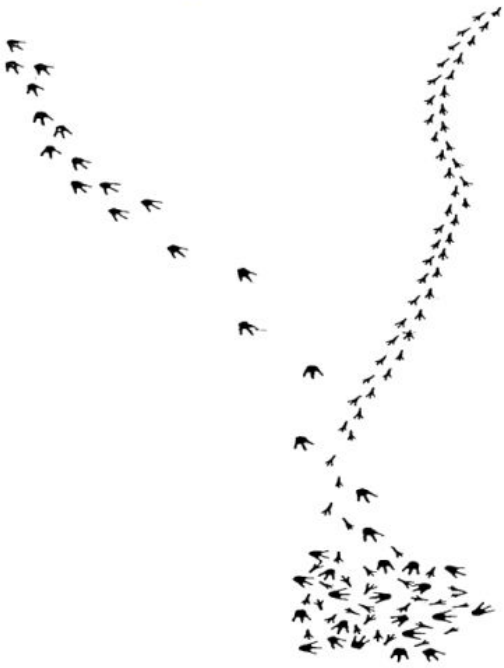
What did you observe?

What did you observe?



TAKWA, MANDIRI, CENDEKIA uny.ac.id

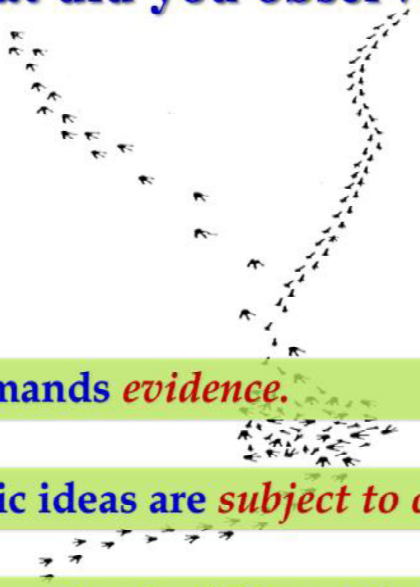
What did you observe?



What did you observe?

TAKWA, MANDIRI, CENDEKIA uny.ac.id

What did you observe?



Science demands *evidence.*

Scientific ideas are *subject to change*

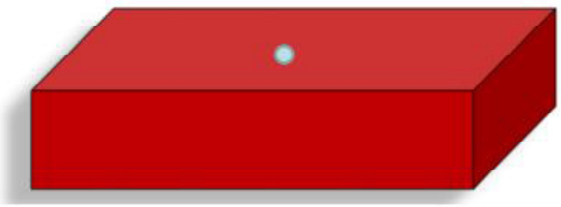
Observation is different from *inference*

Activity (20 min)

The Red Box

- Group in three and observe the red box
- Collect data and discuss to answer:

- What unknown things are in the red box?
  (discuss about how many of things, its/ their figures or shapes, colours, what is it/ are they?)
- Draw the picture/ model



Present your possible answers and models

What did you do?

- You made observation through your senses as many as possible (e.g. touch, knock, listen, smell) in order to find out unknown things in the targeted, observed phenomenon (the Red Box). However, at final, you *cannot* reach the reality.
- You created your own scientific model to represent the abstract phenomenon.

- The world is understandable. (though it is abstract phenomenon)

- Scientific knowledge can be changed (Science is tentative) with new evidences, technology, theories, interpretations.

- Science demands imagination and creativity. (Science is creative and imaginative task) (particularly when scientists create the models)

- Science cannot answer all questions. (e.g. spirit, ghost, God, black magic, etc.)

- In many cases, there is no single right or perfect answer.

Scientific Methods

- The scientific method is the process by which scientists, collectively and over time, endeavor to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world.

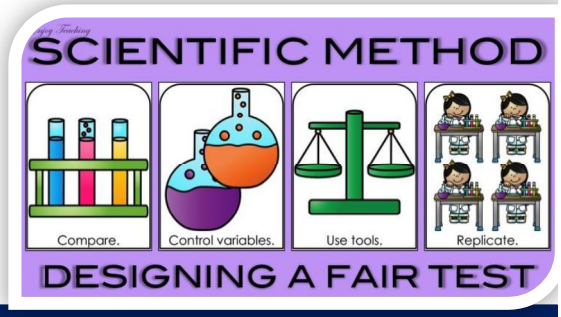
- The scientific method is a way to ask and answer scientific questions by making observations and doing experiments.

The steps of the scientific method are to:

- **Ask a Question**
- **Do Background Research**
- **Construct a Hypothesis**
- **Test Your Hypothesis by Doing an Experiment**
- **Analyze Your Data and Draw a Conclusion**
- **Communicate Your Results**

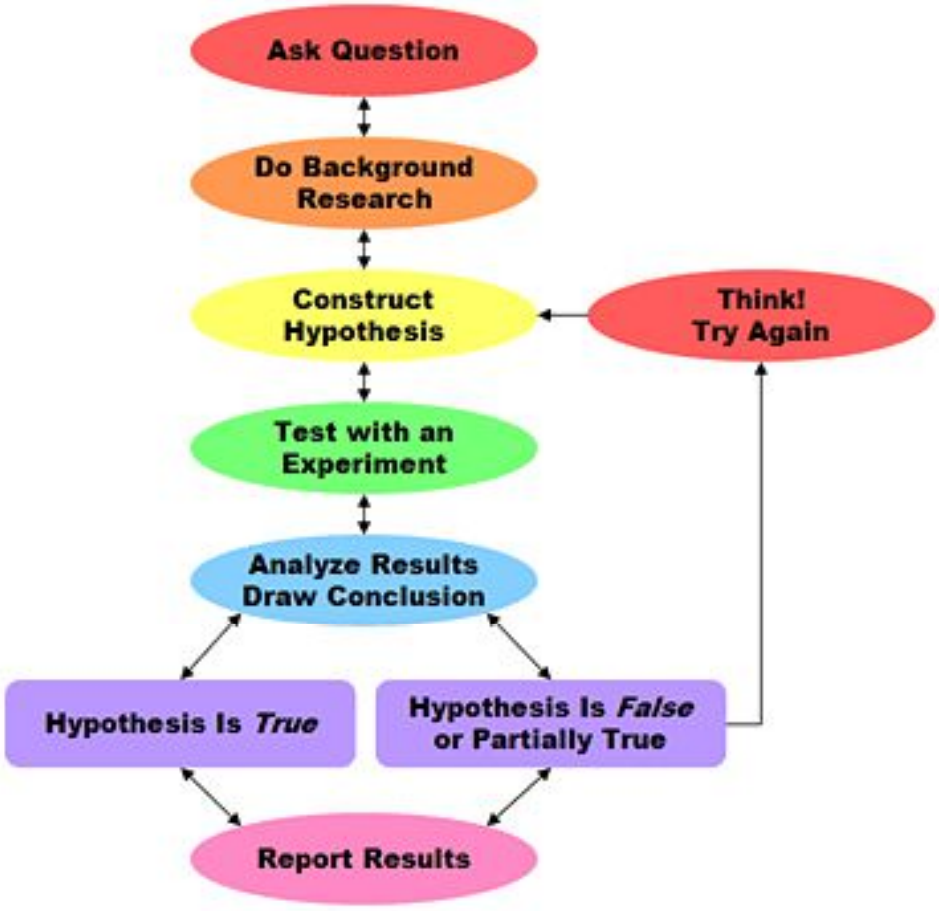
It is important for your experiment to be a fair test

A "fair test" occurs when you change only one factor (variable) and keep all other conditions the same.



Overview of the Scientific Method

- The scientific method is a process for experimentation that is used to explore observations and answer questions. Scientists use the scientific method to search for **cause and effect** relationships in nature. In other words, they design an experiment so that changes to one item cause something else to vary in a predictable way.
- Just as it does for a professional scientist, the scientific method will help you to focus your science fair project question, construct a hypothesis, design, execute, and evaluate your experiment.



Ask a Question:

- The scientific method starts when you ask a question about something that you observe: How, What, When, Who, Which, Why, or Where?
- And, in order for the scientific method to answer the question it must be about something that you can measure, preferably with a number.
- Task : Make Scientific question in your group!

Do Background Research:

- Rather than starting from scratch in putting together a plan for answering your question, you want to be a savvy scientist using library and Internet research to help you find the best way to do things and insure that you don't repeat mistakes from the past.

Construct a Hypothesis:

- A hypothesis is an educated guess about how things work:
  "If _____*[I do this]* _____, then _____*[this]*_____ will happen." You must state your hypothesis in a way that you can easily measure, and of course, your hypothesis should be constructed in a way to help you answer your original question.
- Variables
  Variables for Beginners

variables

- A variable is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: independent, dependent, and controlled.

The **independent variable**

- is the one that is changed by the scientist. To ensure a fair test, a good experiment has only one independent variable. As the scientist changes the independent variable, he or she **observes** what happens.

dependent variable

- The scientist focuses his or her observations on the **dependent variable** to see how it responds to the change made to the independent variable. The new value of the dependent variable is caused by and depends on the value of the independent variable.

controlled variables.

- Controlled variables are quantities that a scientist wants to remain constant, and he must observe them as carefully as the dependent variables.

- Task :
  - Make Hypothesis based on your scientific question
  - Identify variables in your hyphotesis

Test Your Hypothesis by Doing an Experiment:

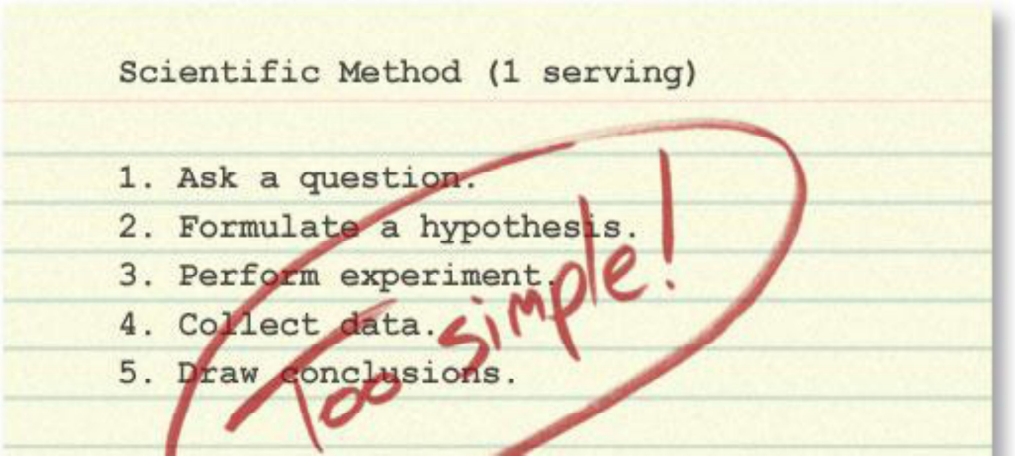
- Your experiment tests whether your hypothesis is true or false. It is important for your experiment to be a fair test. You conduct a fair test by making sure that you change only one factor at a time while keeping all other conditions the same. You should also repeat your experiments several times to make sure that the first results weren't just an accident.

Analyze Your Data and Draw a Conclusion:

- Once your experiment is complete, you collect your measurements and analyze them to see if your hypothesis is true or false. Scientists often find that their hypothesis was false, and in such cases they will construct a new hypothesis starting the entire process of the scientific method over again. Even if they find that their hypothesis was true, they may want to test it again in a new way.

Communicate Your Results:

- To complete your science fair project you will communicate your results to others in a final report and/or a display board. Professional scientists do almost exactly the same thing by publishing their final report in a scientific journal or by presenting their results on a poster at a scientific meeting.



- The Scientific Method is traditionally presented in the first chapter of science textbooks as a simple recipe for performing scientific investigations.

The Limitation of "Traditional Scientific Method"

- The linear, stepwise representation of the process of science is simplified, but it does get at least one thing right. It captures the core logic of science: testing ideas with evidence.
- However, this version of the scientific method is so simplified and rigid that it fails to accurately portray how real science works.

Implications of Using "Traditional Scientific Method"

1. The simplified, linear scientific method implies that scientific studies follow an unvarying, linear recipe.

- **But in reality**, in their work, scientists engage in many different activities in many different sequences. Scientific investigations often involve repeating the same steps many times to account for new information and ideas.

2 The simplified, linear scientific method implies that science is done by individual scientists working through these steps in isolation.

- **But in reality**, science depends on interactions within the scientific community. Different parts of the process of science may be carried out by different people at different times.

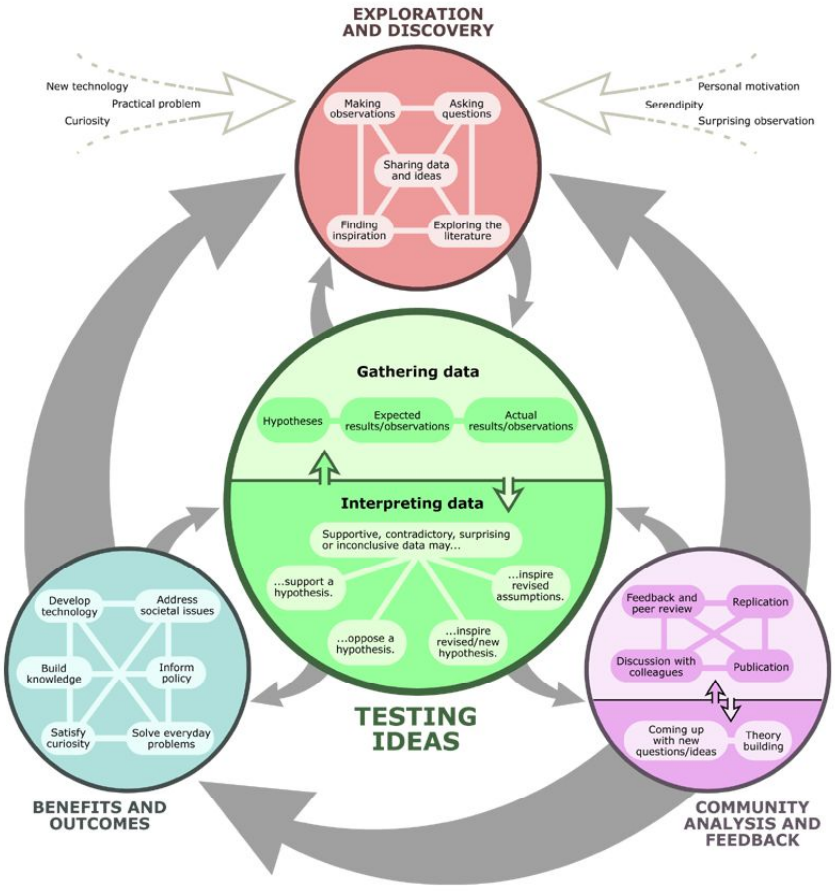
3 The simplified, linear scientific method implies that science has little room for creativity.

- **But in reality**, the process of science is exciting, dynamic, and unpredictable. Science relies on creative people thinking!

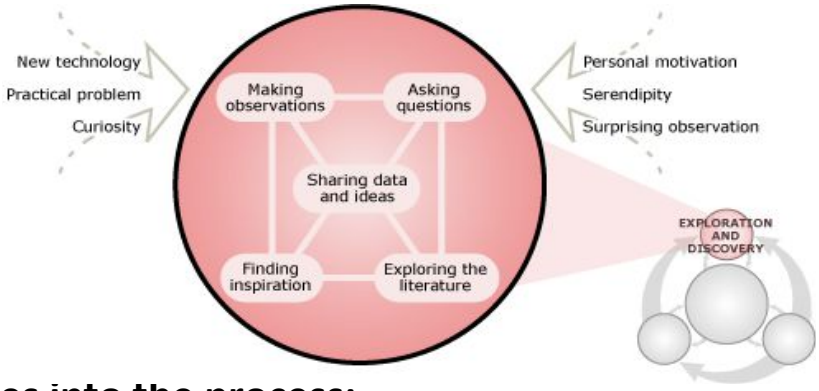
4 The simplified, linear scientific method implies that science concludes.

- **But in reality**, scientific conclusions are always revisable if warranted by the evidence. Scientific investigations are often ongoing, raising new questions even as old ones are answered.

The *real* process of science

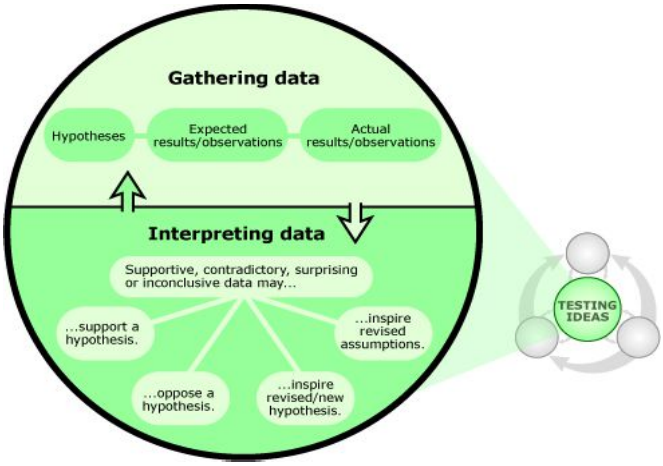


A blueprint for scientific investigations



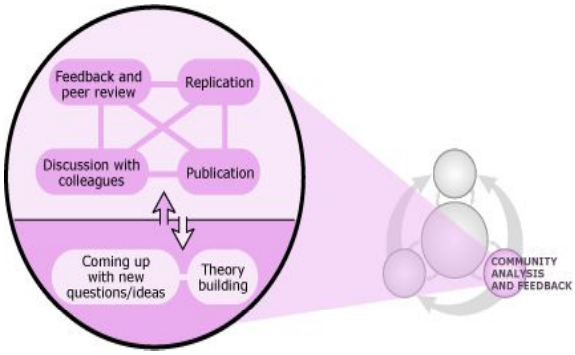
1. **There are many routes into the process:**
   - concern over a practical problem : finding a new treatment for diabetes,
   - technological development : the launch of a more advanced telescope,
   - Curiosity : tinkering, brainstorming, trying to make some new observations, chatting with colleagues about an idea, or doing some reading.

2. Scientific testing is at the heart of the process



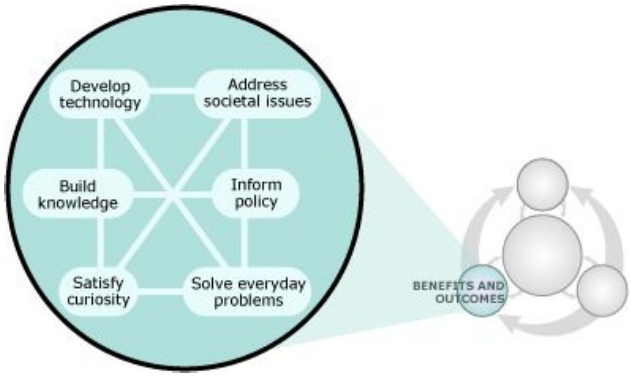
- In science, all ideas are tested with evidence from the natural world, which may take many different forms .
- We can't move through the process of science without examining how that evidence reflects on our ideas about how the world works.

3. The scientific community helps ensure science's accuracy.



- Members of the scientific community (i.e., researchers, technicians, educators, and students, to name a few) play many roles in the process of science, but are especially important in generating ideas, scrutinizing ideas, and weighing the evidence for and against them. Through the action of this community, science is self-correcting.

4. The process of science is intertwined with society.



- The process of science :
  - is influences to society : investigations of X-rays leading to the development of CT scanners, and
  - is influenced by society : a society's concern about the spread of HIV leading to studies of the molecular interactions within the immune system.

THANK YOU

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The Scientific Method involves a series of steps that are used to investigate a natural occurrence.

We shall take a closer look at these steps and the terminology you will need to understand before you start a science project.

Scientific Method

Problem/Question

Observation/Research

Formulate a Hypothesis

Experiment

Collect and Analyze Results

Conclusion

Communicate the Results

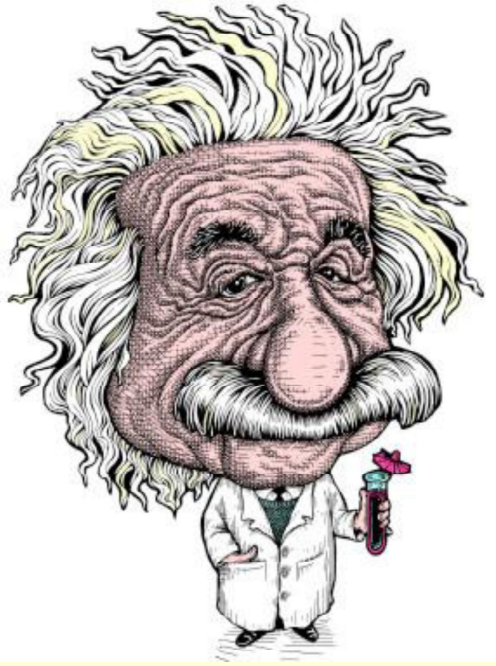
Steps of the Scientific Method

1. Problem/Question: Develop a question or problem that can be solved through experimentation.

Steps of the Scientific Method

2. Observation/Research: Make observations and research your topic of interest.

Do you remember the next step?



Steps of the Scientific Method

3. Formulate a Hypothesis:
Predict a possible answer to the problem or question.

Example: If soil temperatures rise, then plant growth will increase.

Steps of the Scientific Method

4. Experiment: Develop and follow a procedure.

Include a detailed materials list.

The outcome must be measurable (quantifiable).

Steps of the Scientific Method

5. Collect and Analyze Results: Modify the procedure if needed.

Confirm the results by retesting.

Include tables, graphs, and photographs.

Steps of the Scientific Method

6. Conclusion: Include a statement that accepts or rejects the hypothesis.

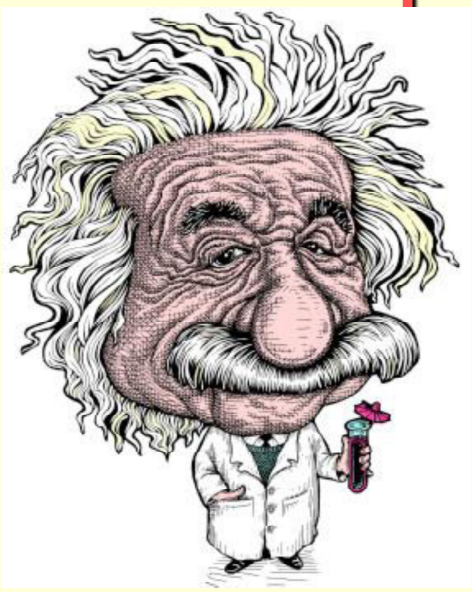
Make recommendations for further study and possible improvements to the procedure.

Steps of the Scientific Method

7. Communicate the Results: Be prepared to present the project to an audience.

Expect questions from the audience.

Think you can name all seven steps?



Let's put our knowledge of the Scientific Method to a realistic example that includes some of the terms you'll be needing to use and understand.

Problem/Question

John watches his grandmother bake bread. He ask his grandmother what makes the bread rise.

She explains that yeast releases a gas as it feeds on sugar.

Problem/Question

John wonders if the amount of sugar used in the recipe will affect the size of the bread loaf?

Caution!

Be careful how you use effect and affect.

Effect is usually a noun and affect, a verb.

“ The effect of sugar amounts on the rising of bread.”

“How does sugar affect the rising of bread?”

Observation/Research

John researches the areas of baking and fermentation and tries to come up with a way to test his question.

He keeps all of his information on this topic in a journal.

John talks with his teacher and she gives him a Experimental Design Diagram to help him set up his investigation.

General Layout for an Experimental Design Diagram

Title

The Effect of _____ (Independent Variable)
on _____ (Dependent Variables)

Hypothesis

If _____ (planned change in independent variable),
then _____ (predicted change in dependent variables).

Independent Variable

_____

Levels of Independent Variable and Numbers of Repeated Trials

Level 1 (Control)	Level 2	Level 3	Level 4
Number of trials	Number of trials	Number of trials	Number of trials

Dependent Variable and How Measured

_____

Constants

1.

2.

3.

4.

Formulate a Hypothesis

After talking with his teacher and conducting further research, he comes up with a hypothesis.

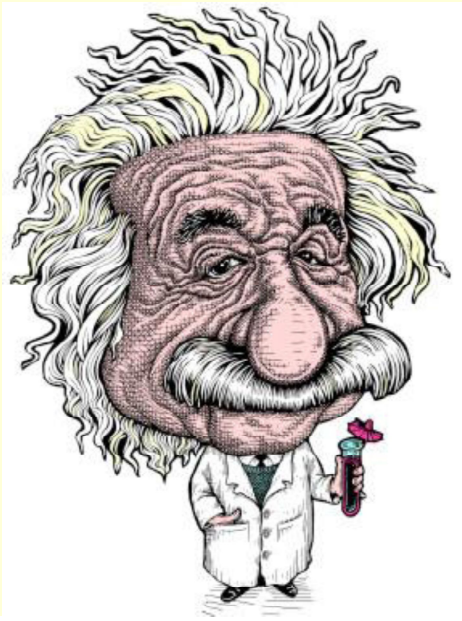
"If more sugar is added, then the bread will rise higher."

Hypothesis

The hypothesis is an educated guess about the relationship between the independent and dependent variables.

Note: These variables will be defined in the next few slides.

Do you know the difference between the independent and dependent variables?



Independent Variable

The independent, or manipulated variable, is a factor that's intentionally varied by the experimenter.

John is going to use 25g., 50g., 100g., 250g., 500g. of sugar in his experiment.

Dependent Variable

The dependent, or responding variable, is the factor that may change as a result of changes made in the independent variable.

In this case, it would be the size of the loaf of bread.

Experiment

His teacher helps him come up with a procedure and list of needed materials.

She discusses with John how to determine the control group.

Control Group

In a scientific experiment, the control is the group that serves as the standard of comparison.

The control group may be a “no treatment" or an “experimenter selected” group.

Control Group

The control group is exposed to the same conditions as the experimental group, except for the variable being tested.

All experiments should have a control group.

Control Group

Because his grandmother always used 50g. of sugar in her recipe, John is going to use that amount in his control group.

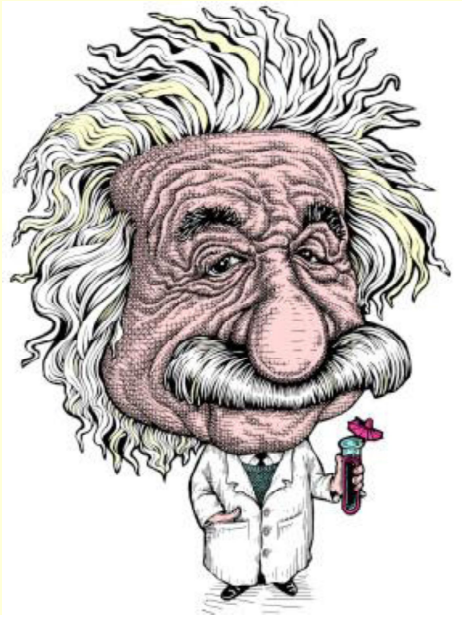
Constants

John's teacher reminds him to keep all other factors the same so that any observed changes in the bread can be attributed to the variation in the amount of sugar.

Constants

The constants in an experiment are all the factors that the experimenter attempts to keep the same.

Can you think of some constants for this experiment?



Constants

They might include:

Other ingredients to the bread recipe, oven used, rise time, brand of ingredients, cooking time, type of pan used, air temperature and humidity where the bread was rising, oven temperature, age of the yeast…

Experiment

John writes out his procedure for his experiment along with a materials list in his journal. He has both of these checked by his teacher where she checks for any safety concerns.

Trials

Trials refer to replicate groups that are exposed to the same conditions in an experiment.

John is going to test each sugar variable 3 times.

Collect and Analyze Results

John comes up with a table he can use to record his data.

John gets all his materials together and carries out his experiment.

Size of Baked Bread (LxWxH) cm^3

	Size of Bread Loaf (cm^3) Trials			
Amt. of Sugar (g.)	1	2	3	Average Size (cm^3)
25	768	744	761	758
50 Control group	1296	1188	1296	1260
100	1188	1080	1080	1116
250	672	576	588	612
500	432	504	360	432

Collect and Analyze Results

John examines his data and notices that his control worked the best in this experiment, but not significantly better than 100g. of sugar.

Conclusion

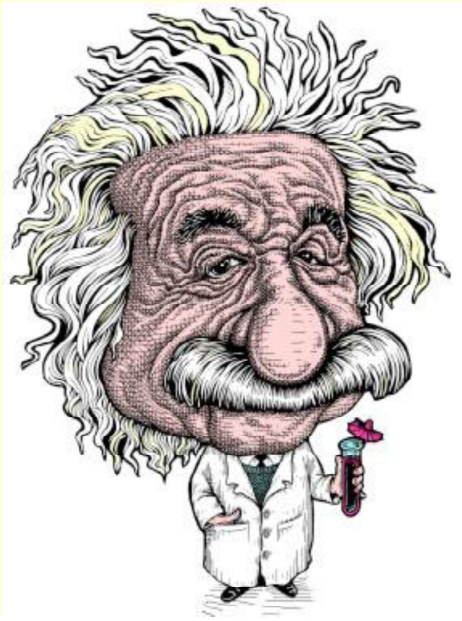
John rejects his hypothesis, but decides to re-test using sugar amounts between 50g. and 100g.

Experiment

Once again, John gathers his materials and carries out his experiment.

Here are the results.

Can you tell which group did the best?



Size of Baked Bread (LxWxH) cm^3

	Size of Bread Loaf (cm^3) Trials			
Amt. of Sugar (g.)	1	2	3	**Average Size (cm^3)**
50 Control group	1296	1440	1296	1344
60	1404	1296	1440	1380
70	1638	1638	1560	1612
80	1404	1296	1296	1332
90	1080	1200	972	1084

Conclusion

John finds that 70g. of sugar produces the largest loaf.

His hypothesis is accepted.

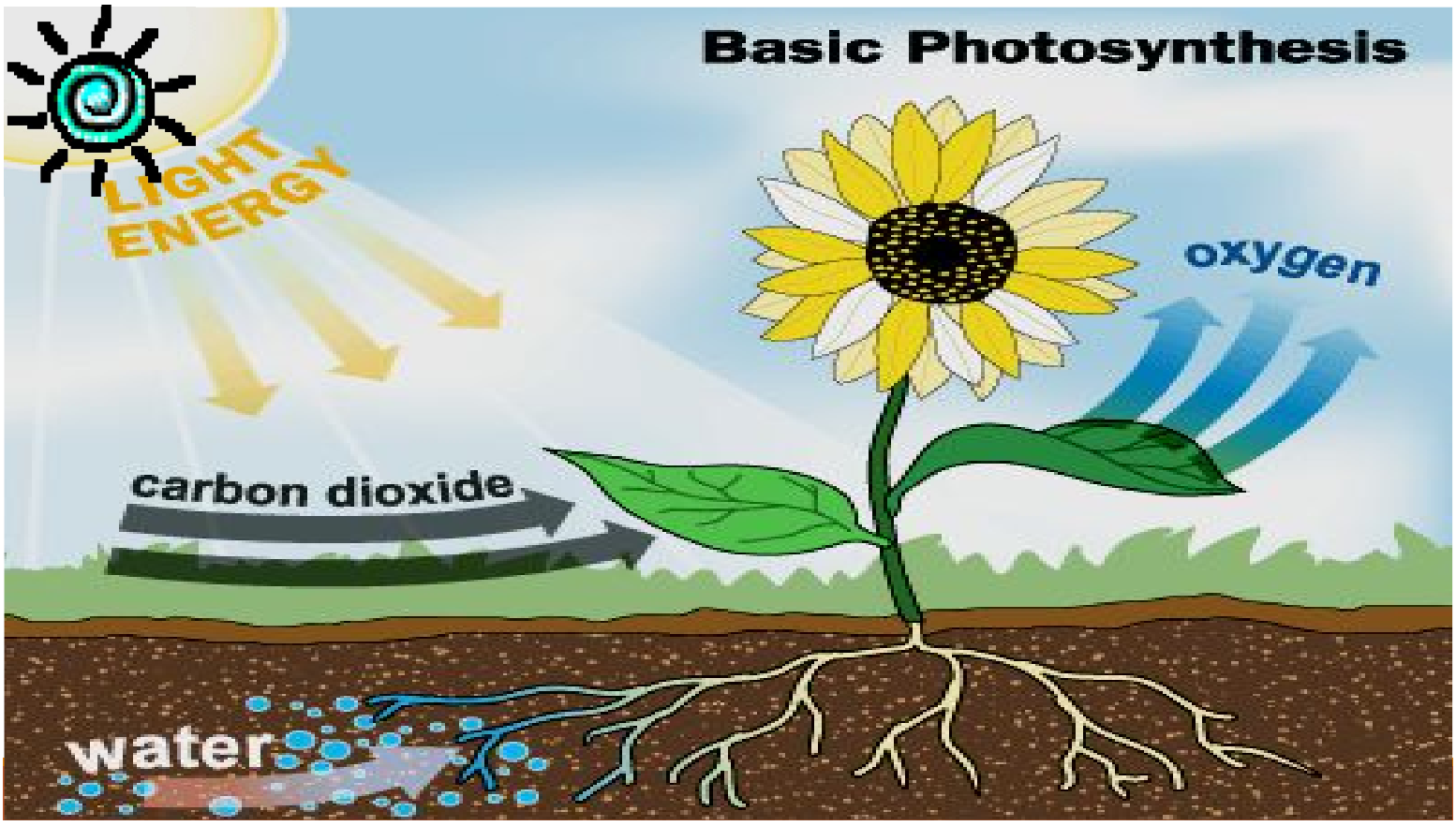
Communicate the Results

John tells his grandmother about his findings and prepares to present his project in Science class.

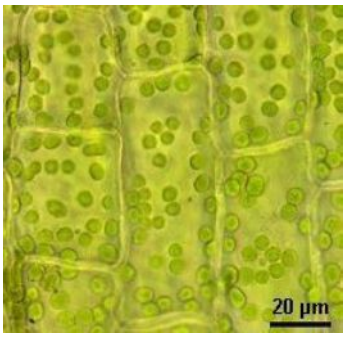
Observe your world and come up with a question to answer using the Scientific Method!

FOTOSINTESIS

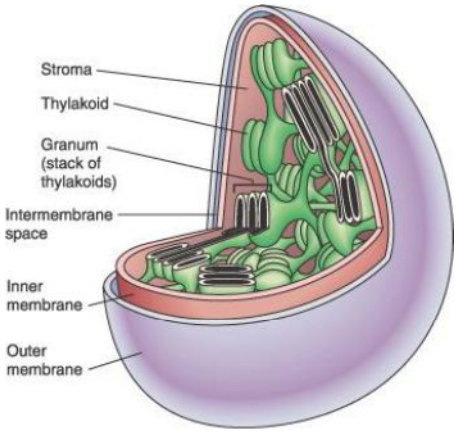
@ Didik Setyawarno
2016



WHY ARE PLANTS GREEN?

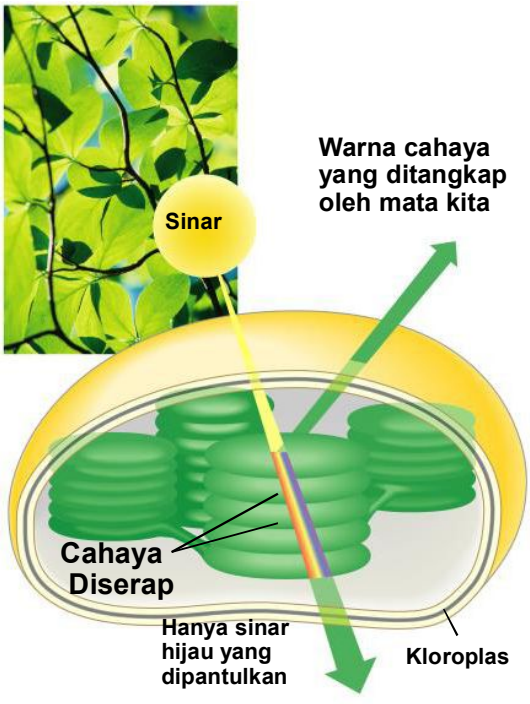


Sel Tumbuhan memiliki kloroplas



Mengapa hanya warna hijau yang mampu ditangkap oleh mata kita?

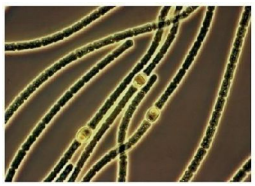
Klorofil mengubah enegi cahaya menjadi energi kimia



Fotosintesis

Pemanfaatan energi cahaya matahari (cahaya matahari buatan) oleh tumbuhan berhijau daun atau bakteri untuk mengubah karbondioksida dan air menjadi karbohidrat.

1.*Euglena*



2.*Cyanobacteria*

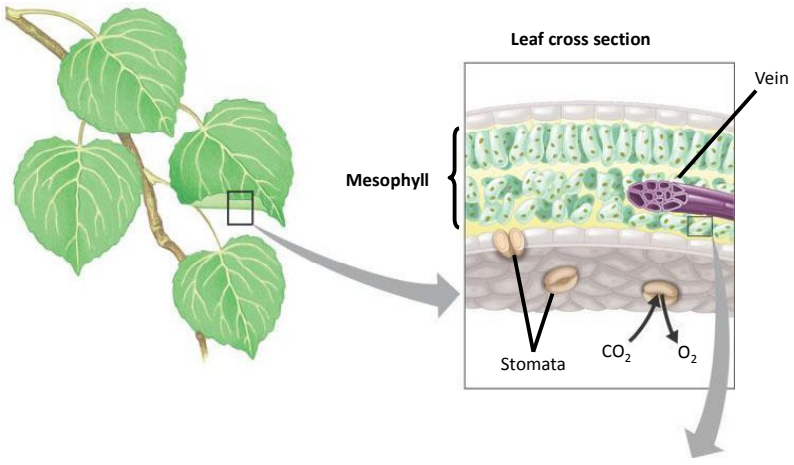
3. *Hydrilla*

Tanaman hijau menggunakan pigmen yang disebut klorofil untuk mengubah energi sinar matahari menjadi energi kimia.

Tanaman mengambil dan menggabungkan energi cahaya dengan enam molekul karbon dioksida dan enam molekul air untuk membentuk satu molekul glukosa dan enam molekul oksigen.

Oksigen adalah produk sampingan dari fotosintesis. Tanaman juga dapat menyimpan energi untuk penggunaan masa depan. Pada dasarnya, proses ini membuat makanan dari energi.

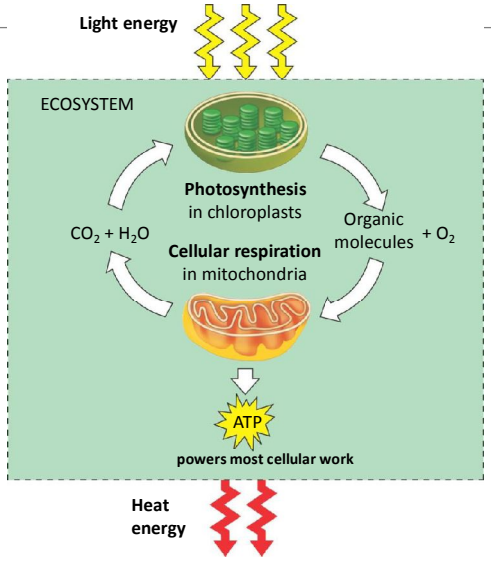
Gula yang dihasilkan oleh fotosintesis digunakan secara langsung dalam respirasi. Biasanya, fotosintesis akan menghasilkan lebih banyak glukosa daripada yang dibutuhkan oleh tanaman.



Fotosintesis terjadi di kloroplas

Daun pada tanaman merupakan tempat utama terjadinya fotosintesis

Energi mengalir ke dalam suatu ekosistem sebagai cahaya matahari dan meninggalkannya dalam bentuk panas

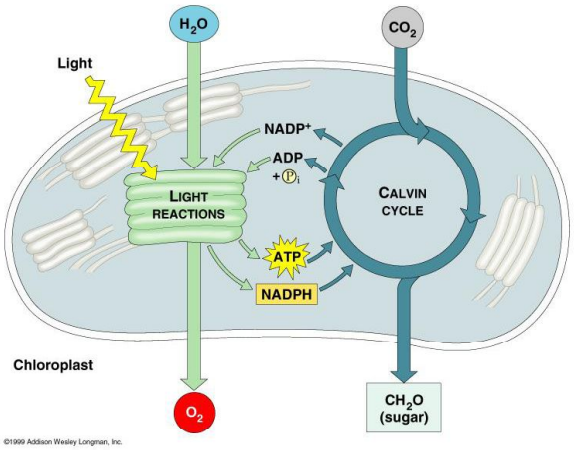


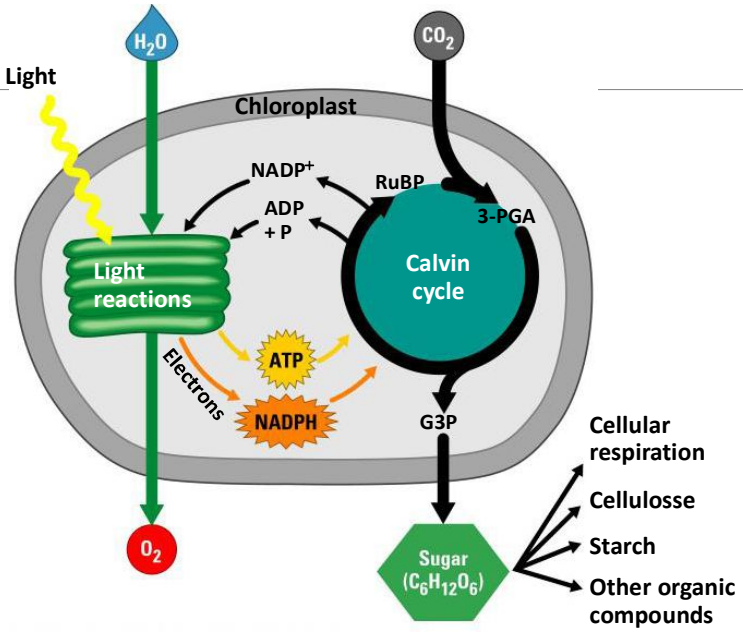
Proses dimana organisme yang memiliki kloroplas mengubah energi cahaya matahari menjadi energi kimia

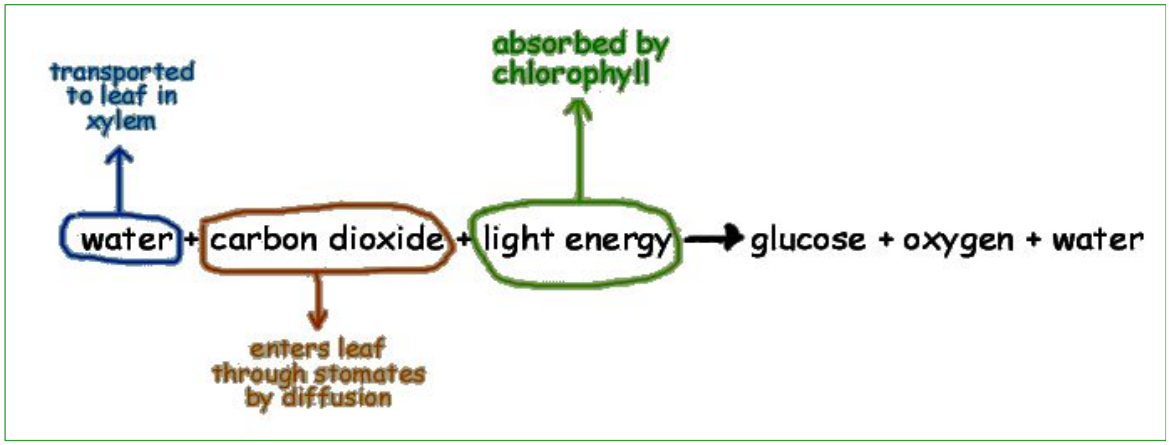
Melibatkan 2 lintasan metabolik

Reaksi terang: mengubah energi matahari menjadi energi seluler

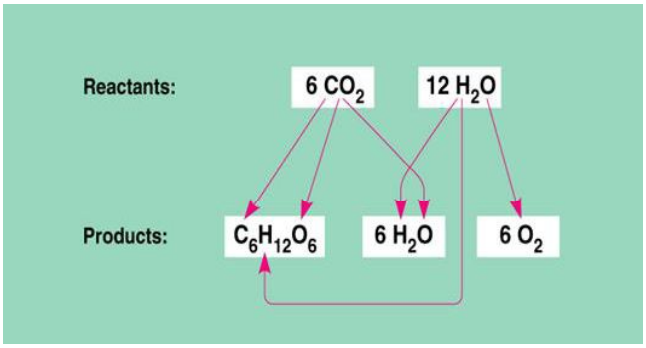
Siklus Calvin: reduksi CO_2 menjadi CH_2O




H_2O
CO_2
Light
Chloroplast
$NADP^+$
ADP
+ P
RuBP
3-PGA
Calvin cycle
Light reactions
ATP
NADPH
Electrons
O_2
G3P
Cellular respiration
Cellulosse
Starch
Other organic compounds
Sugar
($C_6H_{12}O_6$)


transported to leaf in xylem
absorbed by chlorophyll
water
carbon dioxide
light energy
glucose + oxygen + water
enters leaf through stomates by diffusion

Persamaan Fotosintesis

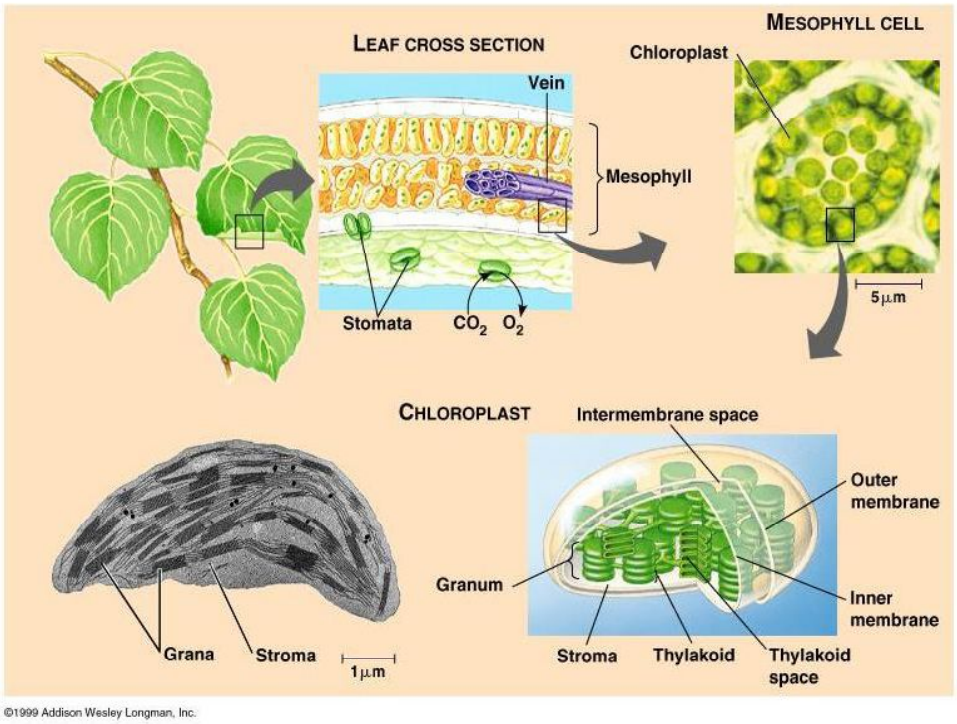


Fotosintesis

$6CO_2 + 6H_20 + light \rightarrow C_6H_{12}0_6 + 6O_2$

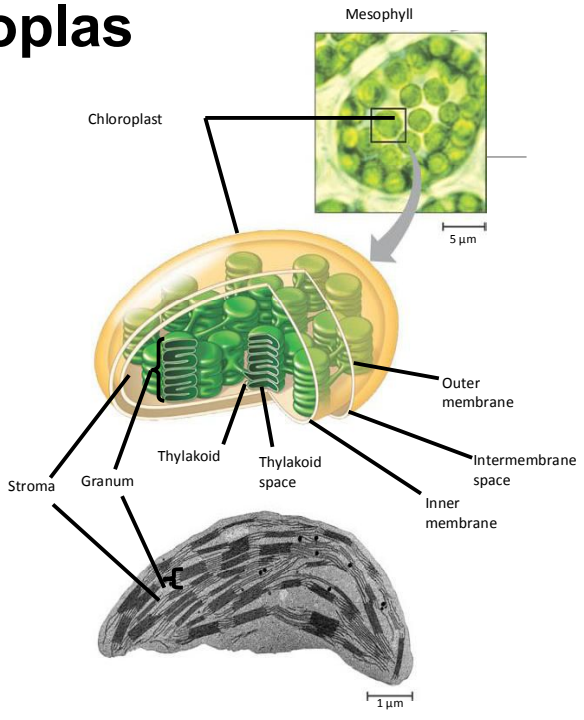
Pada proses fotosintesis, energi dihasilkan dari cahaya matahari yang diserap oleh klorofil. Energi tersebut digunakan untuk memecah molekul air menjadi oksigen dan hidrogen. Oksigen dikeluarkan oleh daun, meskipun sebagian digunakan untuk bernapas. Hidrogen bergabung dengan karbon dioksida membentuk glukosa

Struktur Daun

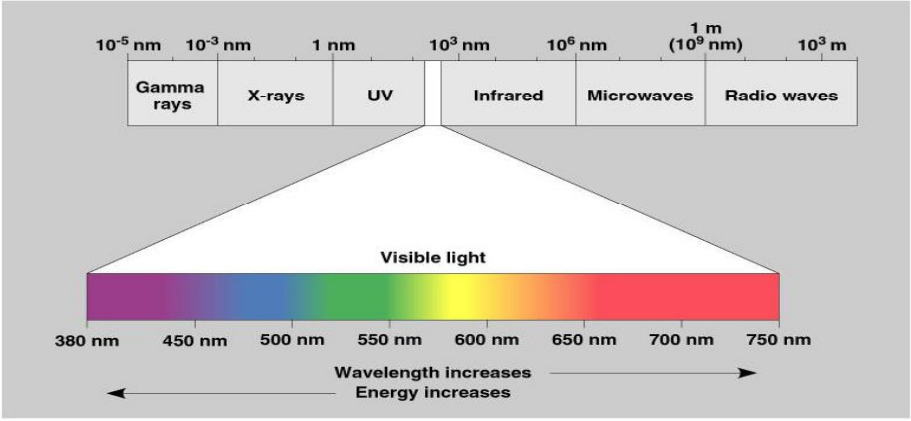


Struktur kloroplas

- Tilakoid adalah sistem membran dalam kloroplas (tempat terjadinya reaksi terang). Memisahkan kloroplas menjadi ruang tilakoid dan stroma
- Grana kumpulan tilakoid dalam kloroplas
- Stroma: daerah cair antara tilakoid dan membran dalam tempat terjadi siklus Calvin

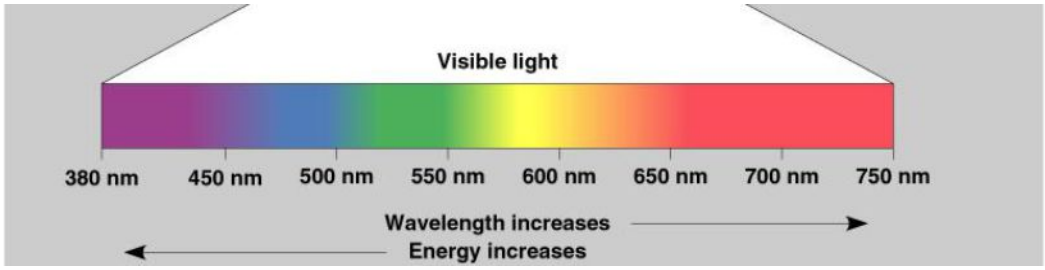


Cahaya



Energi elektromagnetik bergerak dalam bentuk gelombang. Terdapat hubungan yang berbalik antara panjang gelombang dengan energy. Panjang gelombang tinggi maka energi rendah.

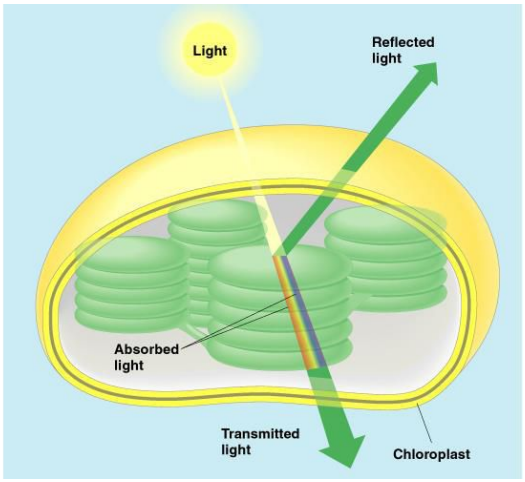
Spektrum tampak

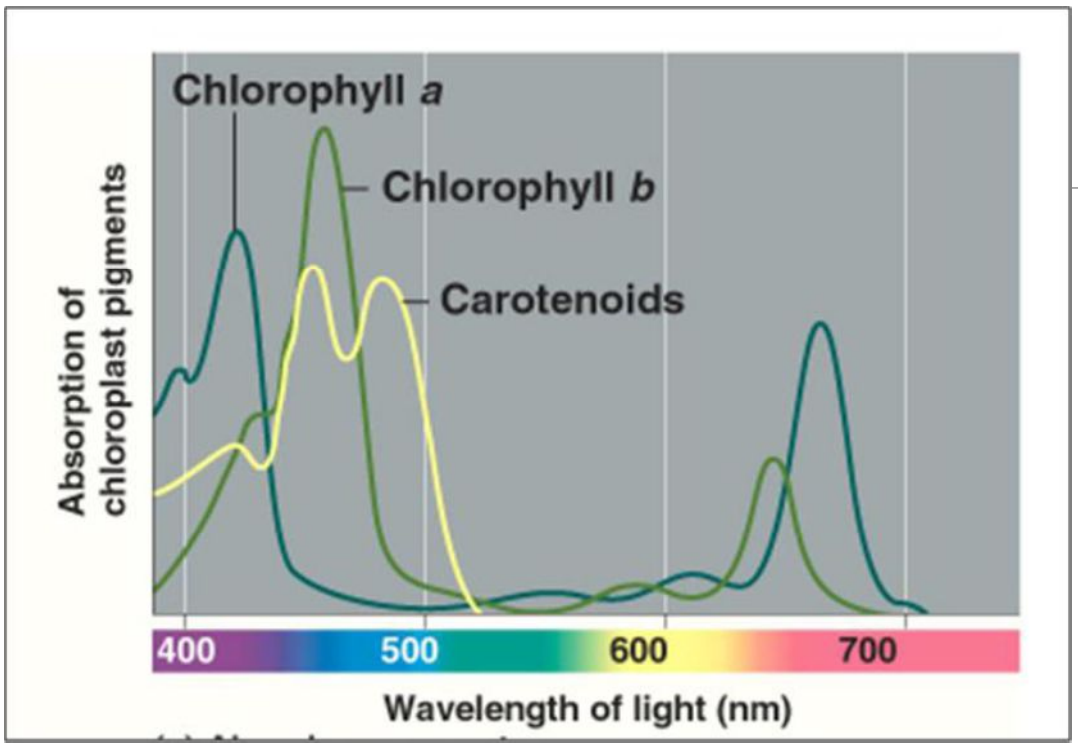


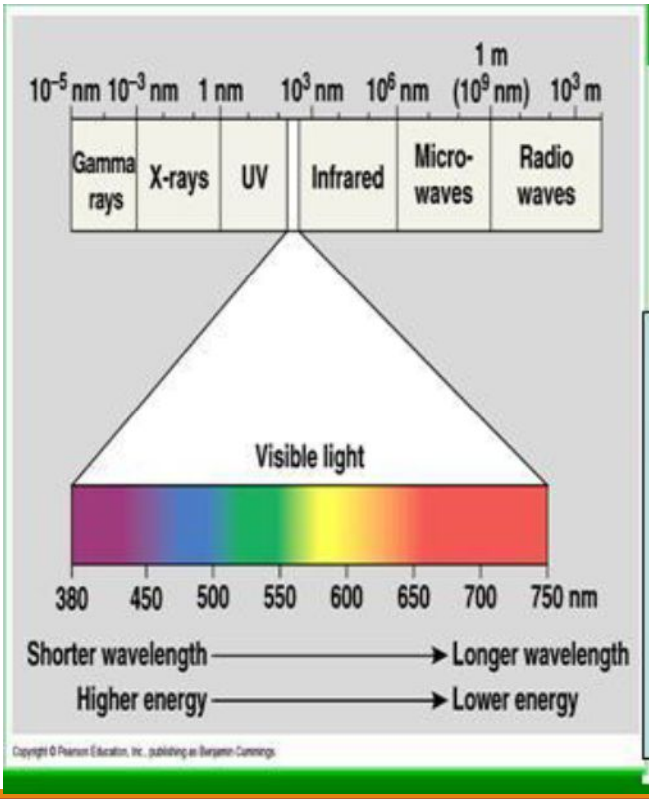
- Termasuk warna-warna cahaya yang dapat kita lihat
- Termasuk panjang gelombang yang menjalankan fotosintesis

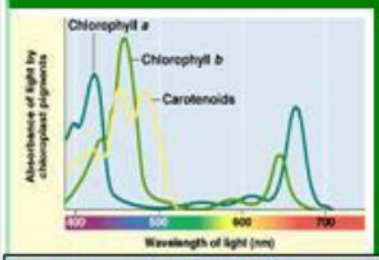
Pigmen

- Substansi yang menyerap cahaya tampak
- Menyerap kebanyakan panjang gelombang tetapi paling sedikit menyerap panjang gelombang hijau.
- Pigmen
  Klorofil *a*
  Klorofil *b*
  Karotenoid
    Karotene, Xantofil





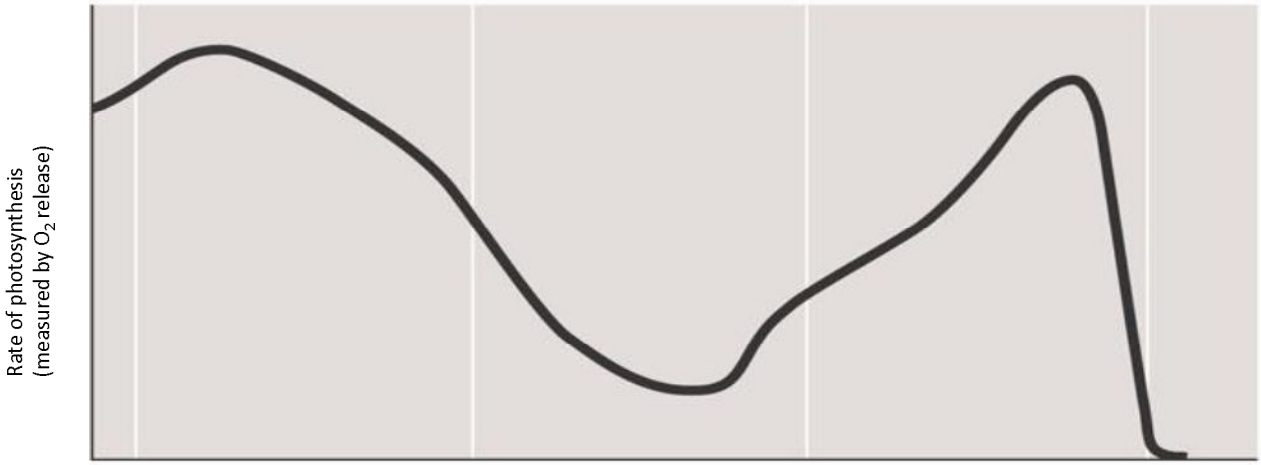




1. Daun menyerap lebih dari 90% cahaya ungu & biru
2. Klorofil menyerap sedikit cahaya hijau
3. Klorofil berwarna hijau menandakan pigmen ini tidak efektif untuk menyerap cahaya hijau
4. Spektrum serapan >< spektrum aksi untuk proses fotosintesis

Spektrum aksi pigmen

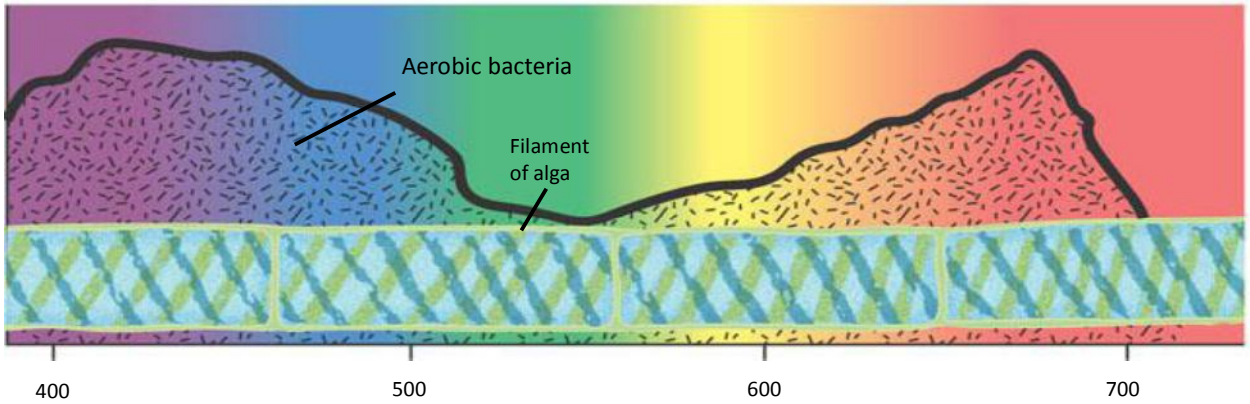
- Efektivitas relatif panjang gelombang yang berbeda dalam menjalankan fotosintesis



Action spectrum. Plot antara kecepatan fotosintesis vs panjang gelombang. Sepktrum aksi mewakili spektrum absorpsi klorofil a tetapi tidak benar-benar tepat. Hal ini karena penyerapan cahaya oleh pigmen aksesoris seperti klorofil b dan karotenoid.

Spektrum aksi fotosintesis

- Ditunjukkan oleh Theodor W. Engelmann

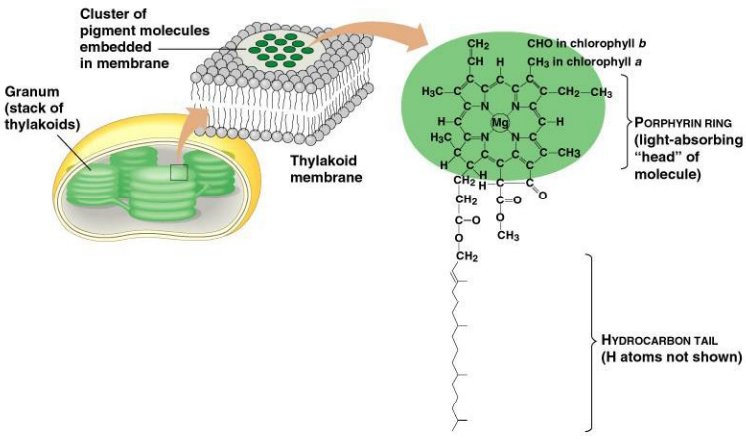


Engelmann's experiment. Tahun 1883, Theodor W. Engelmann menyinari alga filamen dengan cahaya yang telah dilewatkan ke prisma, sehingga segmen yang berbeda dari alga mendapat panjang gelombang yang berbeda. Digunakan bakteri aerob yang terkonsentrasi dekan sumber oksigen untuk menentukan segmen alga yang paling banyak mengeluarkan O2.

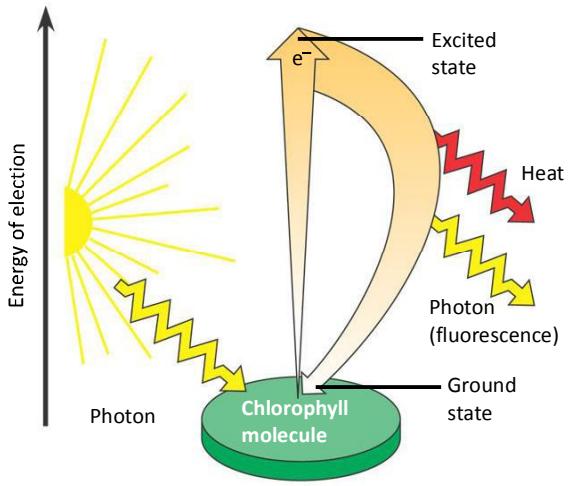
Bakteri berkumpul dalam jumlah besar disekitar alga yang mendapat cahaya biru-violet dan merah.
cahaya biru-violet dan merah paling efektif dalam fotosintesis

Klorofil *a*

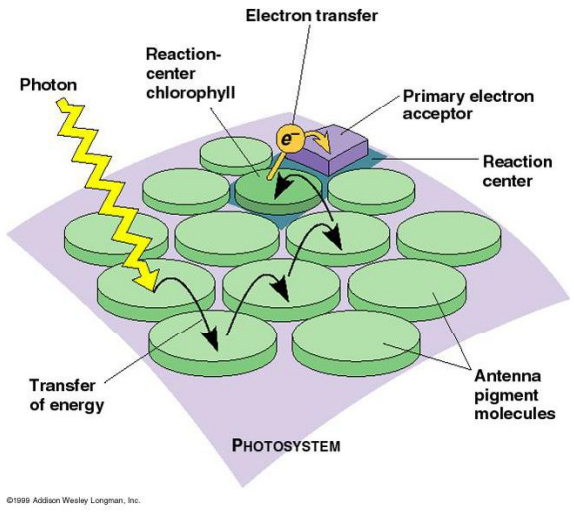
- Klorofil a adalah pigmen yang secara langsung berpartisipasi dalam reaksi terang
- Pigmen lain menambahkan energi ke klorofil a
- Penyerapan cahaya meningkatkan elektron ke orbital energi yang lebih tinggi



- Klorofil tereksitasi oleh cahaya
- Saat pigmen menyerap cahaya
- Klorofil tereksitasi dan menjadi tidak stabil



Fotosistem



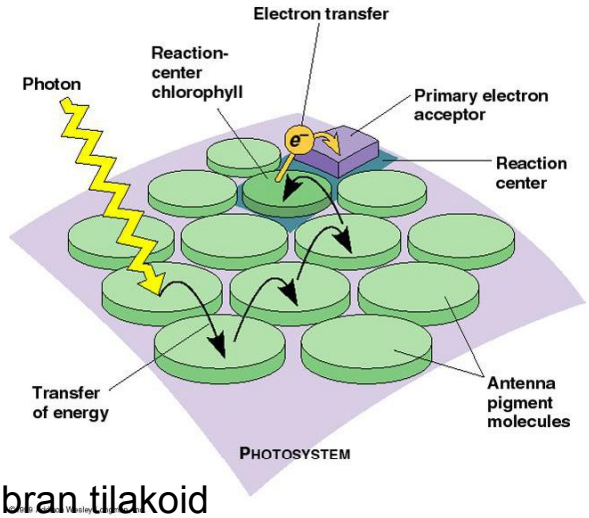
Kumpulan pigmen dan protein yang berasosiasi dengan membran tilakoid yang memanen energi dari elektron yang tereksitasi

Energi yang ditangkap ditransfer antara molekul fotosistem sampai mencapai molekul klorofil pada pusat reaksi

Pada pusat reaksi terdapat 2 molekul
- Klorofil *a*
- Akseptor elektron primer

Pusat reaksi klorofil dioksidasi dengan hilangnya elektron melalui reduksi akseptor elektron primer

Terdapat fotosistem I dan II



- Membran tilakoid
  - Terdapat 2 tipe fotosistem yaitu fotosistem I dan II

Aliran elektron

Terdapat dua rute jalur elektron yang tersimpan pada akseptor elektron primer

Kedua jalur
- Dimulai dengan penangkapan energi foton
- Menggunakan rantai transport elektron dengan sitokrom untuk kemiosmosis

Aliran elektron

Aliran elektron nonsiklik

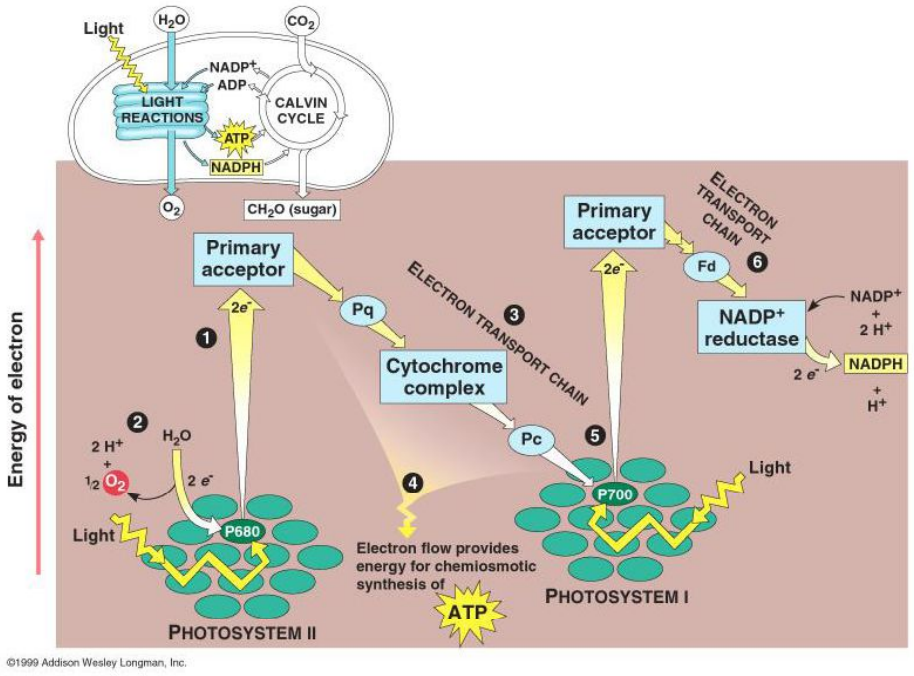
- Menggunakan fotosistem II dan I
- Elektron dari fotosistem II dihilangkan dan diganti oleh elektron yang didonasikan oleh air
- Mensintesis ATP dan NADPH
- Donasi elektron mengkonversi air O_2 dan $2H^+$

Aliran elektron siklik

- Hanya menggunakan fotosistem I
- Elektron dari fotosistem I di-recycle
- Mensintesis ATP

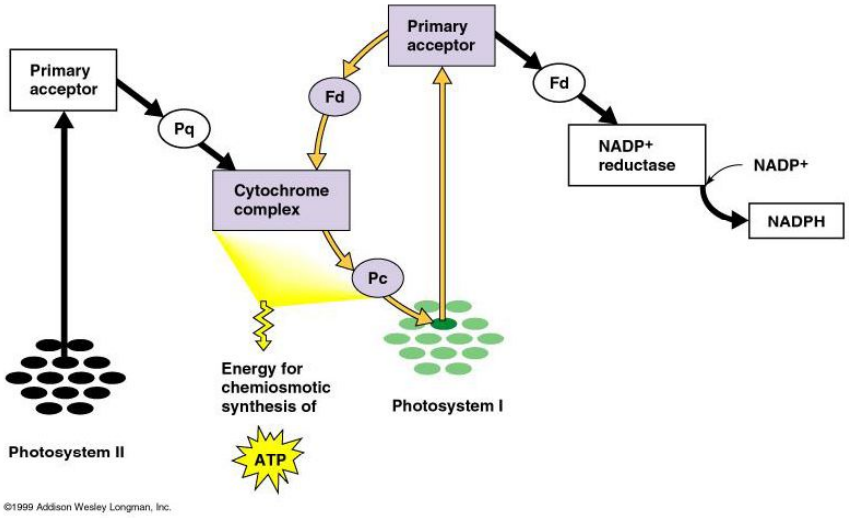
Nonsiklik

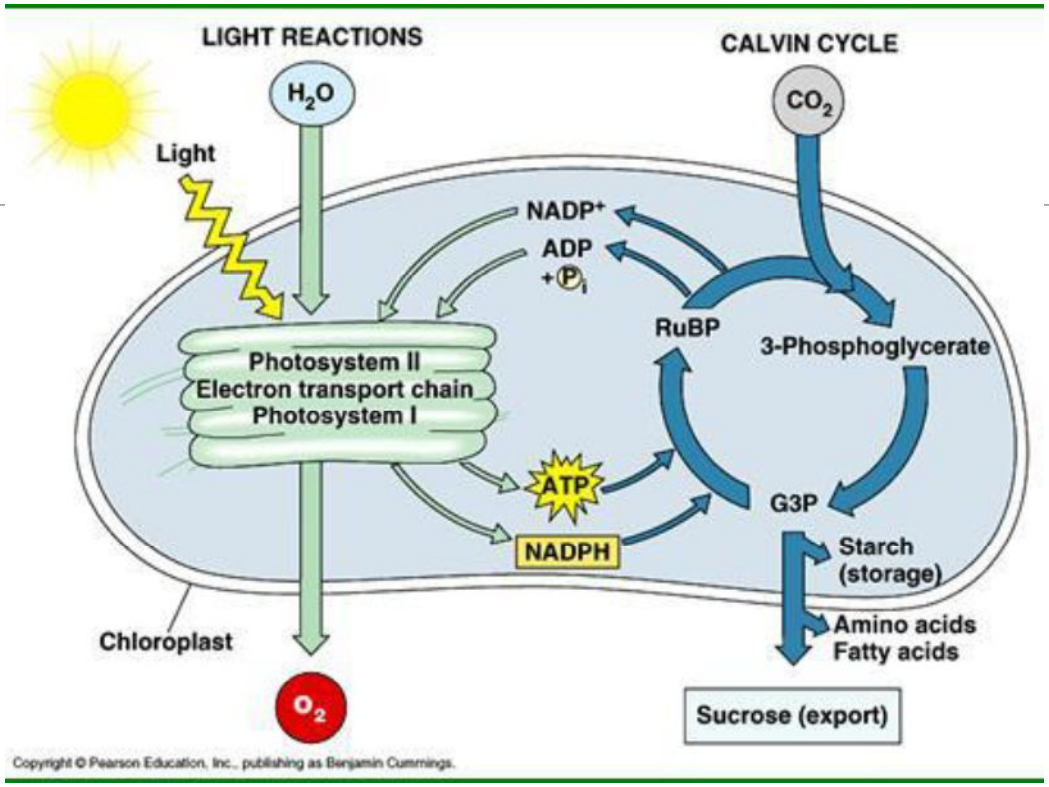
Menghasilkan NADPH, ATP, dan oksigen



Aliran siklik

- Hanya fotosistem I yang digunakan
- Hanya ATP yang dihasilkan



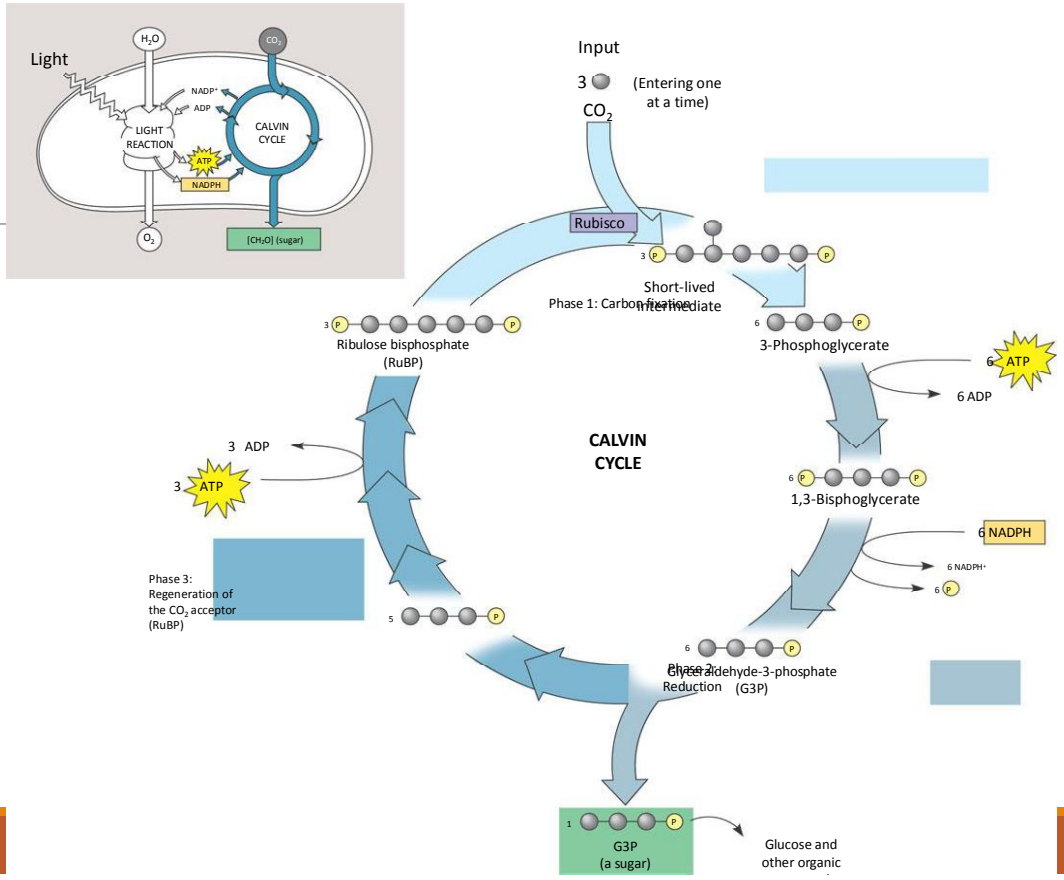


Siklus Calvin menggunakan ATP dan NADPH untuk mengkonversi CO_2 menjadi gula

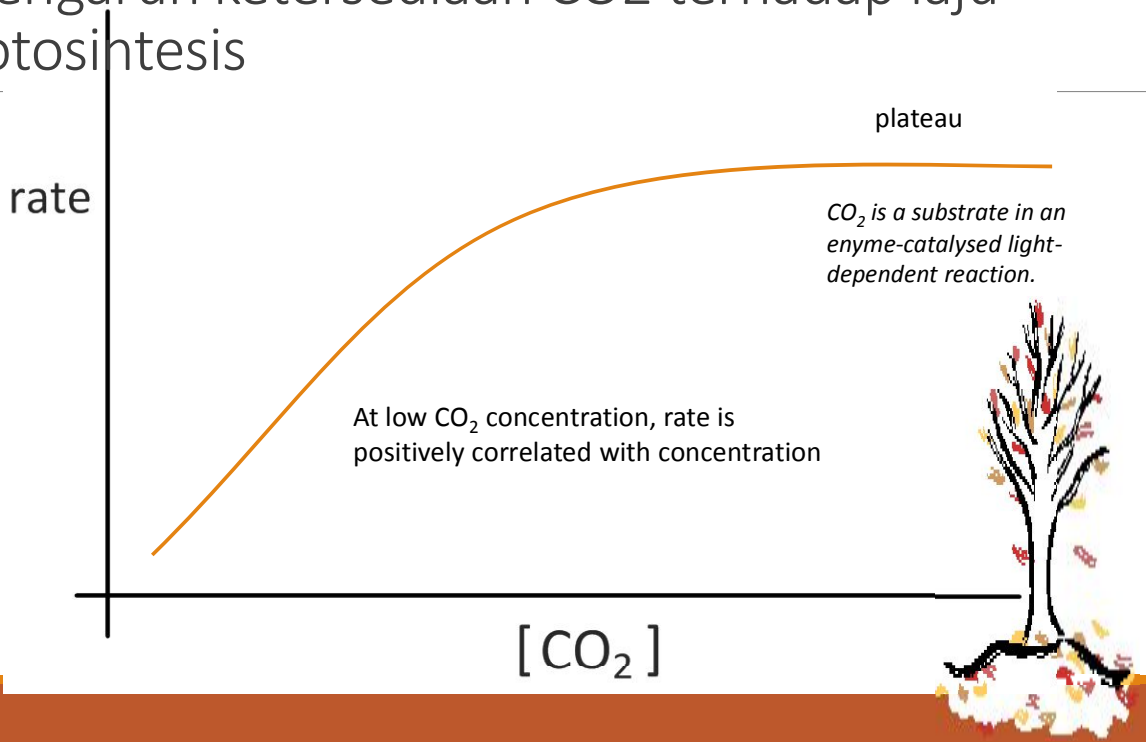
- Siklus calvin
  - Terjadi di stroma

- Siklus Calvin memiliki 3 tahap
  - Fiksasi karbon
  - Reduksi
  - Regenerasi akseptor CO_2

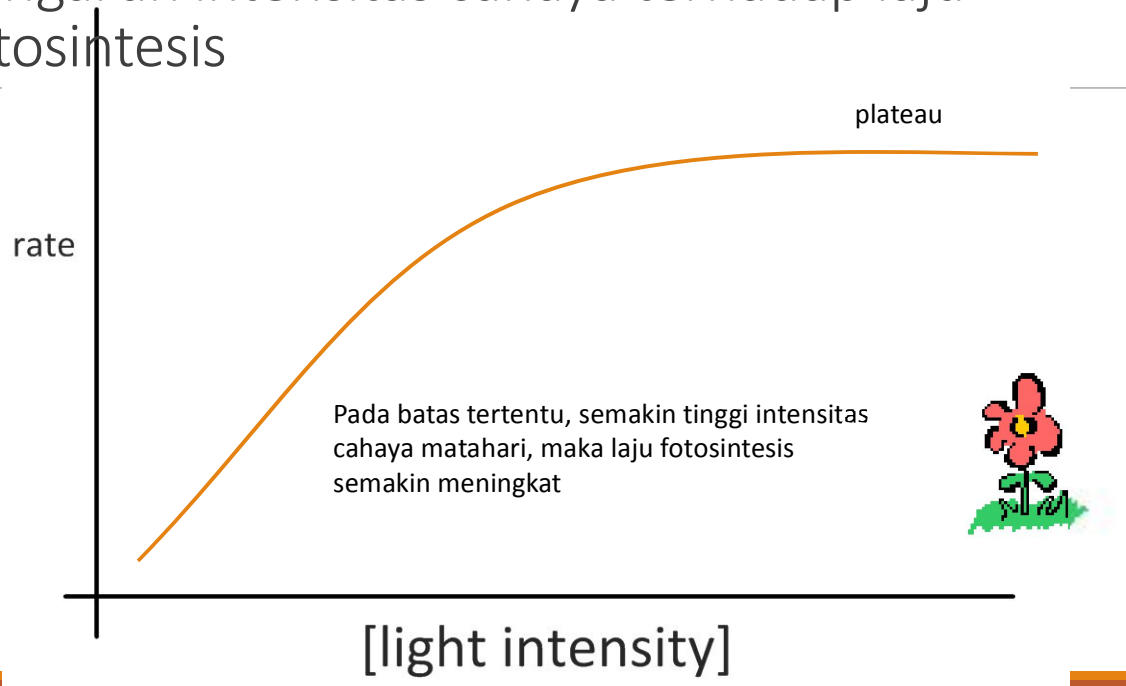
Siklus Calvin



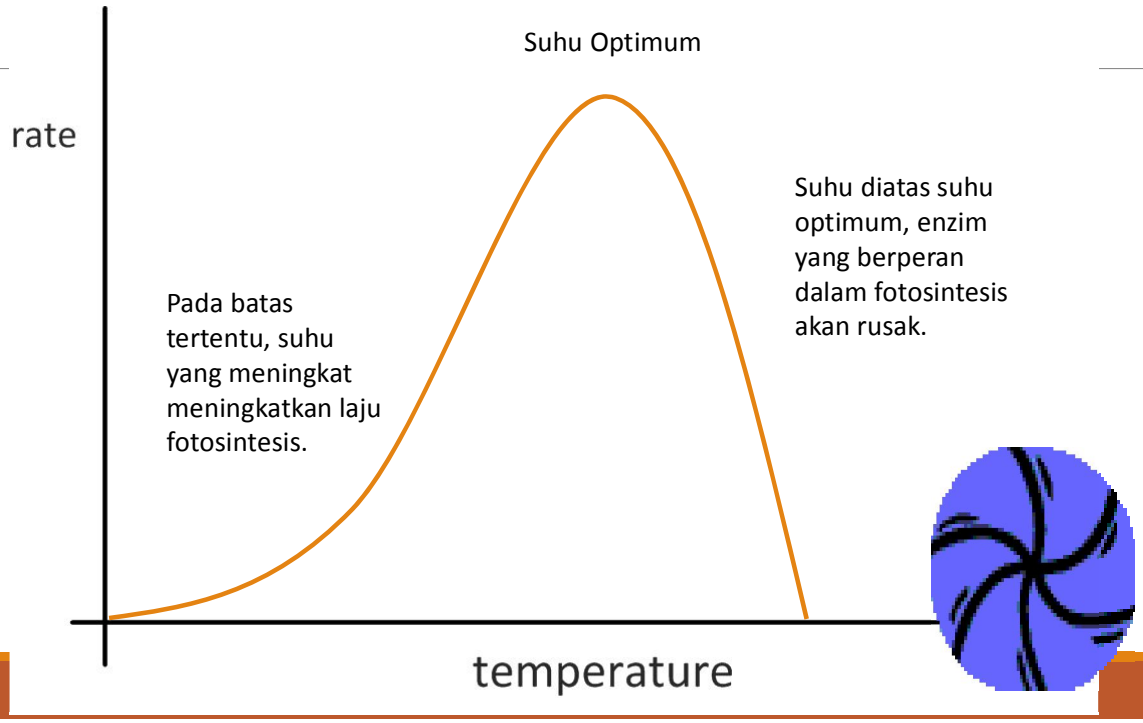
Pengaruh ketersediaan CO2 terhadap laju fotosintesis



Pengaruh intensitas cahaya terhadap laju fotosintesis



Pengaruh suhu terhadap laju fotosintesis



Percobaan Fotosintesis

“Tanaman yang dipaparkan dibawah cahaya akan menghasilkan O2”

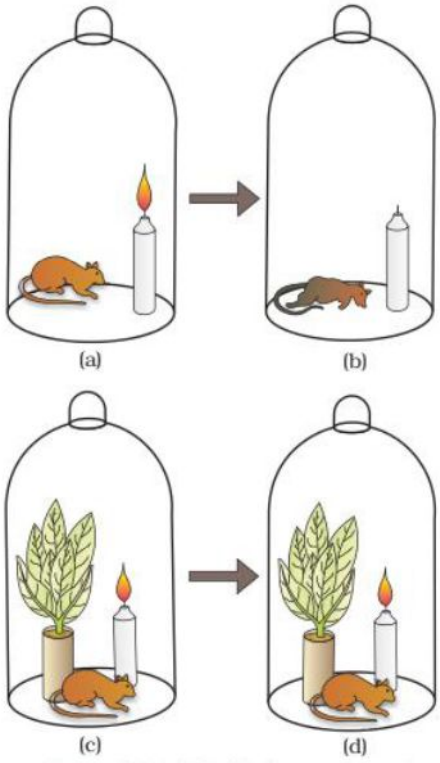
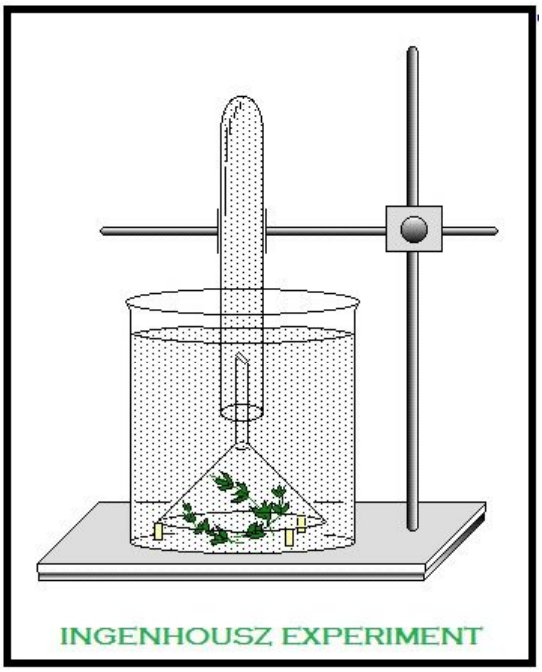


Figure 13.1 Priestley's experiment

“Mengetahui fungsi cahaya, klorofil dalam proses fotosintesis serta CO2 sebagai sumber karbon bagi tumbuhan hijau”



“Pati (Amilum) dihasilkan dalam daun pada proses fotosintesis tumbuhan hijau”