http://smtom.lecture.ub.ac.id/
Password:

https://syukur16tom.wordpress.com/
Password:

LECTURE 01: INTRODUCTION

SPES (*Self-Propagating Education Systems*)

Don't wait somebody else to make you intelligent.

No one prohibit you to be a great human being, but you

Teaching to fish is not enough, and to feed many others is teach a man to learn "e-fishing systems"

LEARNING OUTCOMES

After the completion of this lecture and mastering the lecture materials, students should be able

1. to explain basic concept of plant growth analysis encompassing Growth Law and Growth Process.
2. to explain the intrinsic meaning of plant growth and plant growth analysis.
3. to explain plant characteristics encompassing the nature of plants and the ontogenetic drift of plants.
4. to explain system approach in the analysis of plant growth.
5. to explain biological system of plants in relation to plant growth analysis.

LECTURE OUTLINE

1. BASIC CONCEPT
   - -Growth Law
   - -Growth Process
2. DEFINITION
   - Plant Growth
   - Plant Growth Analysis
3. PLANT SYSTEM
   1. Plant Characteristics
   2. System Approach
   3. Biological System of Plants

Chapter 1:
Sitompul, S.M. (2016).

COURSE PLAN

No.	Subject	No.	
1..	Plant Growth	9.	Phenology and Partitioning
2.	Plant and Environment	10.	Introduction to Models
3.	Plant Growth Parameters	11.	Empirical Models
4.	Approach of Plant Growth Analysis	12.	Conceptual Model
5.	Plant Growth Analysis I	13.	Plant Growth Model I: Linear, Exponential & Monomolecular Model
6.	Plant Growth Analysis II	14.	Plant Growth Model II: Logistic, Gompertz and other Models
7.	Crop Growth Analysis	15.	Cahaya dan Pertumbuhan Tanaman
8.	**MID SMESTER EXAM**		**FINAL SMESTER EXAM**

STRUCTURED TASK

1. English Presentation
   - ~~Every student has to make English Presentation~~
2. Dictionary
   - Take your English dictionary every time I give my lecture
3. My Dictionary (*it is good for you*)
   - Buy a writing book (100-pages) and name it MY DICTIONARY.
   - Write down all English words with Indonesian meanings that you do not know yet.
4. Study Groups
   - Organize your study group, 5 member each to discuss the lecture materials

5. Literature Study
   - Undertake literature study, and *print the papers you have red, at least 3 international papers, and show the papers with notes about the papers* in lecture 3).
6. Paper (NO COVER, NO COVER, NO COVER)
   - Get data (*plant age, leaf area & total dry weight*) from students' "S1 Skripsi" (use excel) including information on the experiment (*pot/field exp., date, months, years, location*) and the name of student.
   - Analyze plant growth indices *(e.g. AGR/CGR, RGR, NAR, LAD etc.) and make graphs (use excel).*
   - Report the results of analysis (*graphs*) in a paper (single space, 12 font times new roman) and *submit it in lecture 5 with data in excel in groups based on plant species*).

An example of data compilation

Title of "Skripsi"			
Name of Student			
Year of Skripsi			
Type of Experiment	Pot/Field		
Location			
Species & Variety			
Spacings (cm)			
Plang age (days)	LA* (cm2/…?)	TDW (g/…?)	SDW (g/…?)
7			
14			
28			
56			
70			
Note* unit: cm^2/plant or m^2, and g/plant or m^2			

1. INTRODUCTION

1. Plant growth will continue to be a highly important object of study as long as the living organisms are dependent upon the various products of plants.
2. This is related to function of plant growth with physiological processes that converts substrates (CO_2, H_2O and Nutrients) to plant biomass including the plant yield.
3. The basic principle of plant growth analysis is that a good or high yield can be acquired only from a good plant growth.
4. The study of plant growth is thus crucial in the effort to obtain a high yield and to evaluate the effects of environmental factors or genotypes (certain genetic manipulations) as well as production managements.

5. Therefore, the plant growth can be used to explain the products of plants obtained at certain conditions in the interaction of genotype and environment.
6. Plant growth becomes a fundamental biological process studied in a wide range of scientific fields, integrating across scales from physiology to community dynamics and ecosystem properties.
7. It is therefore of great importance to have a sound understanding of plant growth in the context of crop cultivation.
8. In the last decade, HPGA (High-throughput Plant Growth Analysis) as a new computational model is developing in order to precisely model plant growth rate.

2. BASIC CONCEPT

- Plant growth analysis is only an approach to study and comprehend plant growth including plant development.
- It is important to remind the fact that plant growth is the process determining the plant yield.
- With rapid development in genetic engineering as well as *omic* and *high-throughput* technologies, it may however raise a question as to the position and status of plant growth analysis.
- Genetic engineering cannot be evaluated directly to enact a certain genetic combination as the right combination in term of plant growth including plant yield.
- Plant growth analysis is the final analysis to qualify products of those technologies.

1. Growth Law

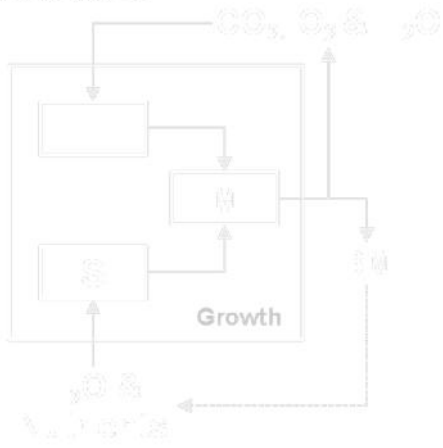
- Plant growth analysis, originating at the end of the nineteenth century, develops rapidly after the concept of "***the compound interest law and plant growth***" was published by V.H. Blackman in 1919.
- This law of plant growth states that plant growth is determined by the rate of interest invested in the productive parts of plants.
- This law complements the Law of the Minimum popularized previously by Justus von Liebig that *the growth or yield of a plant is determined by whichever nutrient is in least amount relative to the required amount.*
- Based on the above law and orher scientific information on plant growth, the law of plant growth can be developed as follows;

1. Plant growth is determined by the initial condition (capital) of plants and the productivity of the capital.
2. Plant growth is controlled by the genetic program of plants that interacts with environmental factors.
3. The growth rate of plants with a certain genetic constituent is determined by the environmental factor available at a lowest quantity relative to the optimum requirement.

1.1 Growth Process

- Plant growth can be regarded as a process that is unseen, but can be undestood or analyzed on the basis of its output and input.
- The process of plant growth is very complex and can be envisaged as consisting of three complex proses; (i) Photosynthesis (**F**), (ii) Nutrient uptake (**S**) and (iii) Metabolism (**M**) with plant biomass (BM) as its main product.

F: Photosynthesis, S: Nutrient uptake, M: Metabolism, and BM: plant biomass.



Gambar 1.1. Plant growth as an integration processes

- In addition to biomass (BM), plants also produce and use oxygen (O_2). Thereby plants are implicated in the global cycle of O_2 and vital in the life perpetuity of living organisms.

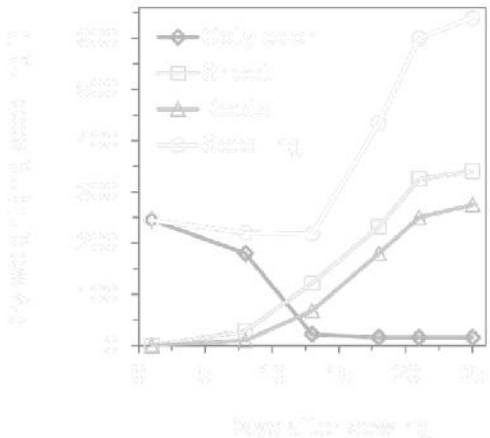
Fig. 1.2. O_2 cycle in nature. Encyclopdia Britanica, 2009

2. DEFINITION

1. Plant Growth

- Plant growth is defined as "***an irreversible increase in size of a plant in plant life cycle***".
- Growth is the increase in dry mass, volume, length, or area that results from the division, expansion, and differentiation of cells (Tessmer *et al*., 2013).
- Other definitions of plant growth considered by several biologists with its respective primacy involve protoplasm propagation, cell multiplication, and volume increase.
- However, no one definition that can satisfy for all conditions including plant dry weight and the number of cells.

- The use of biomass as a parameter of plant growth is not applicable for all conditions.



The growth of *Phaseolus vulgaris* L. under light. Source: based on the data of Díaz-Ruiz (2012)

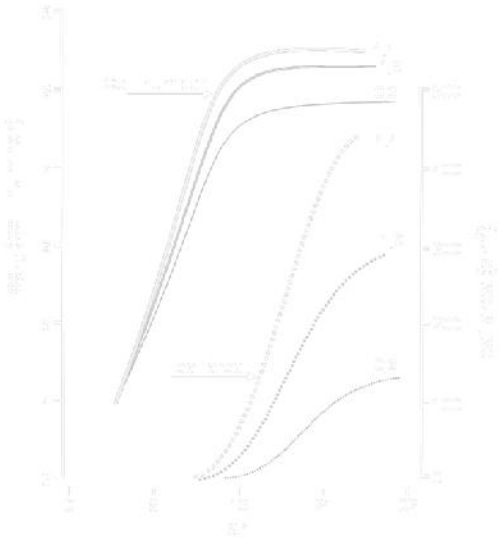


Fig. 1.5 The development of cell number and leaf area with time from the second node of Cucumber grown in a growth cabinet with different light intensity (0,6, 1,9 or 4,4 MJ m^{-2} day^{-1}). Atwell *et al*. (1999) from Milthorpe & Newton (1963)

2.2 Plant Growth Analysis

- The term plant growth analysis refers to a useful set of quantitative methods that describe and interpret the performance of whole **plant** systems grown under natural, seminatural, or controlled conditions. Therefore, (Hunt, 2003).
  - Plant growth analysis is an explanatory, holistic and integrative approach to **interpreting plant form and function**.
- Growth analysis is a conceptual framework for resolving the nature of genotype × environment interactions on plant growth and development (Atwell *et al*., 1999).
  - It uses simple primary data in the form of weights, areas, volumes and contents of plant components **to investigate processes within and involving the whole plant** (Evans, 1972; Causton and Venus, 1981; Hunt, 1990).

- The genotype (genetic) × environment interactions can be illustrated by the regeneration of tissues in Arabidopsis.

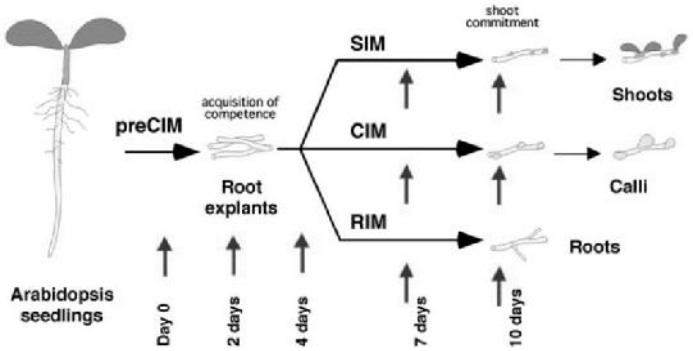


Fig. Regeneration of tissues in Arabidopsis with preCIM (*preincubation in Callus Induction Medium*), SIM (*Shoot Induction Medium*), and RIM (*Root Induction Medium*). Source: adapted from Che *et al*.(2006)

- Plant growth analysis can be also defined as a way or method to find the root cause of a problem through causal relationship as applied in Why analysis.
- This is similar to root cause analysis applied in the management of Toyota by Sakichi Toyota. By answering why questions, the root cause of a problem will be found as illustrated below (the kingdom was lost for want of a nail).

1. For want of a nail a shoe was lost,
2. for want of a shoe a horse was lost,
3. for want of a horse a rider was lost,
4. for want of a rider an army was lost,
5. for want of an army a battle was lost,
6. for want of a battle the war was lost,
7. for want of the war the kingdom was lost

3. PLANT SYSTEM

1. Plant Nature

1.1 Natural Characteristics

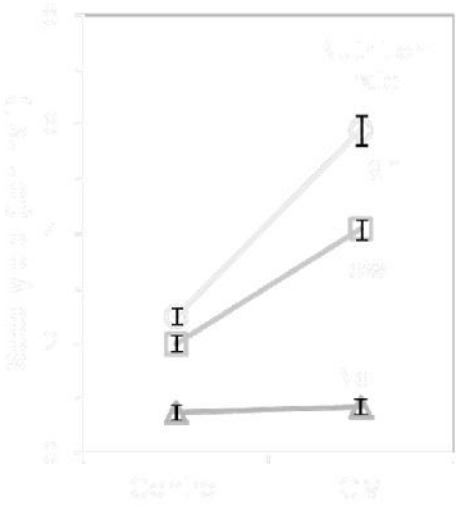
- Sufficient recognition of plant nature or characteristics will be helpful in the development of plant systems that are the basic foundation of plant growth analysis in a systematic way.
- One fact that should be remembered in the recognition of plants is that plants growing in their natural habitat (without disruption) are objects far from the reach of research.
- This is due to the fact that most, if not all, methods involve plant disturbance.

- Other fact is that the nature or performance of plants including plant growth (P) is the product of genetic (G) and environmental (E) interaction.

  P = (G x E)

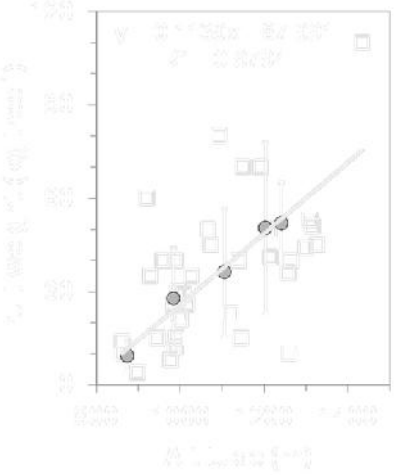
  This interaction can be evaluated in an experiment when 2 or more genotypes and environments are involved
- Results of a study that involved wild type wheat (control) and mutant wheat (GM) that contains gene *Pm3b* controlling the resistance of wheat plants to *powdery mildew* showed the role of environment.
- It was found that the seed yield of mutant wheat increased with an increase in the supply of nutrients. This demonstrated the role of environmental factors on the growth of plants which is the base of experiments to be carried out on relatively homogenous conditions.

The interaction of genetic and environmental factors on the yield of wheat.



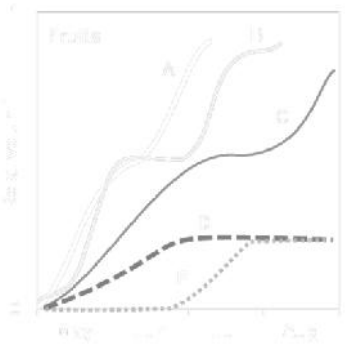
Control = wild type wheat, GM = genetically modified wheat that contains *Pm3b* gene controlling plant resistance to *powdery mildew* (*Pm3b*). Sumber: Zeller *et al*. (2010)

- Plants grown in environments different from their natural habitats may not grow normally.
- For instance, appel trees (*Malus sylvestris* Mill.) cultivated in the tropics (Malang, East Java) bear no fruits at area below certain altitudes.



1.2 Ontogeny

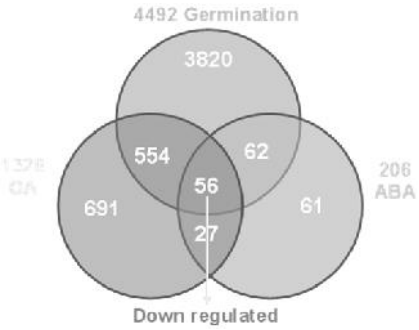
- The genetic control on plant growth and development is realized through protein synthesis that changes with time like the drift of water stream for the information flow from DNA to protein.
- Ontogenetic drift is a term used to describe the flow of Genetic information that controls changes in the performance of plants (plant growth) including germination.



Ontogenetic drift of cherry fruits
(A. early Richmond & B. English morello) and parts of peach fruits (C. pericarp & D. cell nuclei & E. Embryo)

- Seed germination is a complex multi-stage developmental process, and mainly accomplished through concerted activities of many genes.
- Germination, GA and ABA differentially regulated genes were compared and displayed as Venn diagrams.

56 germination responsive genes were differentially regulated by GA and ABA.
43 out of the 56 germination responsive genes were regulated coordinately by GA, and antagonistically by ABA.
17 of the genes were up-regulated by both GA and germination, but down-regulated by ABA.
26 genes were down-regulated by both GA and germination, but upregulated by ABA.



2. System Approach

- With the complexity of plants and growth process in natural systems, system approach originating from systems thinking is required.
- Systems thinking is used in a variety of scientific and technological fields. Indeed, this paradigm has proved indispensable in disciplines as disparate as commerce, production, and the aviation industry.
- Aleksander Bogdanov (1873–1928) was probably the first exponent of systems thinking.
- Bogdanov proposed that all physical, biological, and human sciences could be unified by treating them as sets of relationships and by seeking the organizational principles that underlie all systems (Poustilnik, 1998; Gutiérrez *et al*., 2005).

- The foundation of general systems theory was later developed extensively by the biologist Ludwig von Bertalanffy (for review, see von Bertalanffy, 1968).
- A systems approach to understanding biology can be described as an iterative process that includes
  (1) data collection and integration of all available information (ideally all components and their relationships in the organism),
  (2) system modeling,
  (3) experimentation at a global level, and
  (4) generation of new hypotheses (Fig. 1).
- The promise of systems biology is that by using this approach we will greatly increase our understanding as well as obtain a holistic view of the form and function of biological systems.

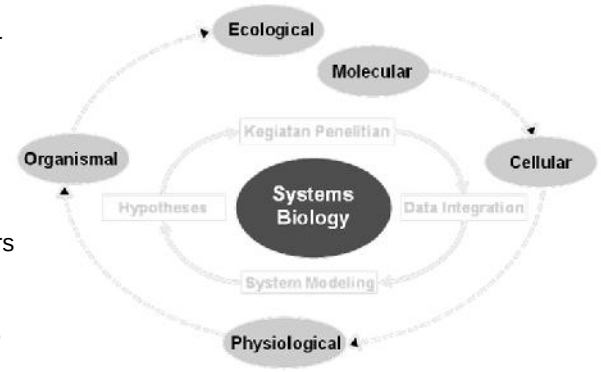


Fig.1. Systems biology for the Virtual Plant. The ultimate goal of systems biology applied to plant research is to generate a model of the plant as a whole that describes processes across all layers of biological organization (molecular, cellular, physiological, organismal, and ecological; peripheral spiral, dotted arrows).

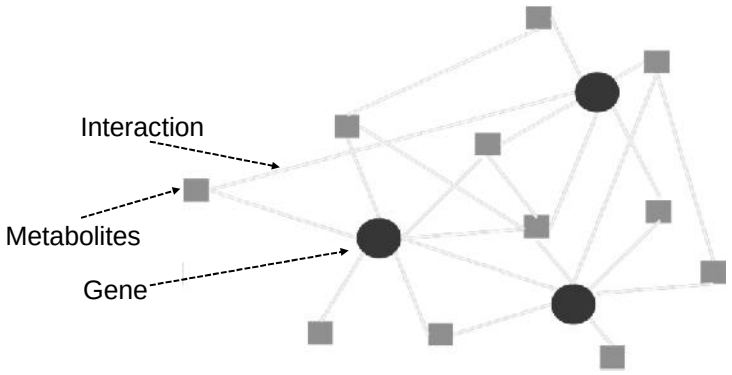
Systems biology embodies an iterative process of experimentation at a global level, data integration, system modeling, and generation of hypotheses (internal cycle, solid arrows). These hypotheses lead to the design of new experiments that start a new round of the cycle. Each iteration refines the model and deepens our biological understanding of the system. Ultimately, such models may be used in a predictive mode and applied to improving traits associated with agriculture.

3. Systems Biology of Plants

- The development of modern **Systems Biology** was driven by the need to assimilate the large amounts of data generated by genome-scale studies into biologically meaningful interpretations.
- Nevertheless, the definition of systems biology is still contentious; some researchers emphasize the role of dynamic modeling, whereas others stress multidimensional data analysis.
- Yuan *et al*. (2008) defined systems biology as the study of interactions among biological components using models and/or networks to integrate genes, metabolites, proteins, regulatory elements and other biological components.

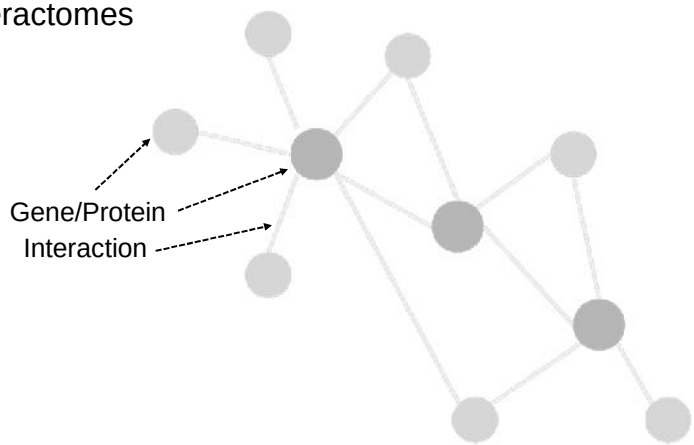
- The four common networks used in plant systems biology study are shown below.

(a) The gene-to-metabolite network



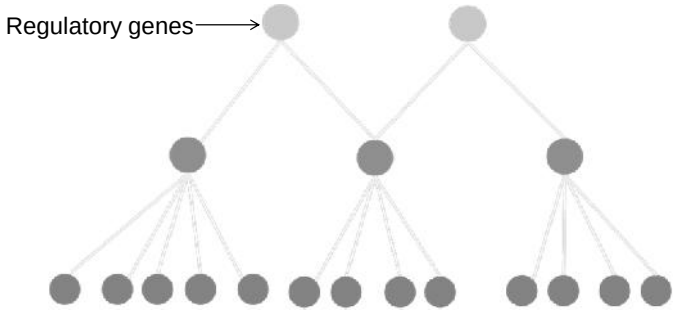
It is often derived from correlation analysis of gene and metabolite profiling under multiple conditions.

(b) Interactomes



This can be derived from genetic or protein-binding assays such as yeast two-hybrid assay and co-immunoprecipitation. The genes in centralized hub locations with many interactions among multiple genes are often symbolized with a different color

(c) The transcriptional regulatory network

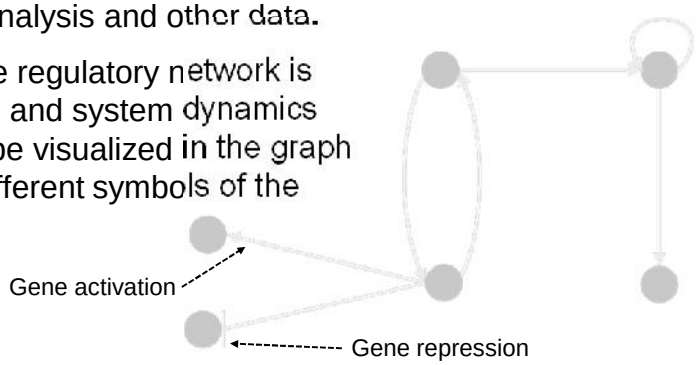


This is highly diverse and can be presented as a hierarchical structure. The elements at the top are expected to be general regulatory genes

(d) The gene regulatory network

This can be derived from gene expression profiles, mutant analysis and other data**.**

The gene regulatory network is dynamic, and system dynamics need to be visualized in the graph by the different symbols of the lines.



The genes and the interactions between genes are often represented by circles and lines respectively. Different symbols at the end of the lines can describe different types of interactions, including gene activation and repression.

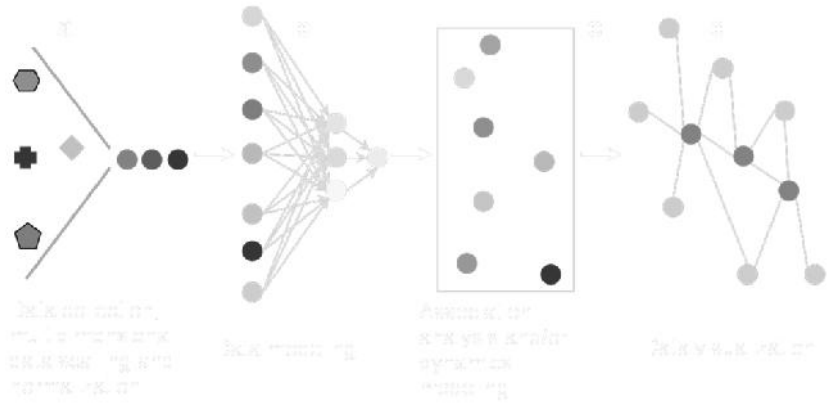


Fig. 1.21 The application of bioinformatics in systems biology. This can be divided into four stages. Source: Yuan *et al*. (2008)

WHAT HAVE YOU G0T?

1. What is the basic principle of plant growth analysis
2. What is the study approach being developed to model plant growth rate
3. What is the concept (Law) that initiated the development of plant growth analysis
4. What is the fist factor determining the growth of plants
5. What are the processes implicated in the growth process
6. What is the definition of plants growth
7. What does it mean by plant growth analysis
8. What is ontogenetic drift
9. What are the steps in systems approach
10. What are the common networks used in plant systems biology?


THANK YOU
http://leavingbio.net/the%20Structure%20and%20Functions%20of%20Flowers%5B1%5D.htm
Спасибо
謝謝
شكراً
37