

Science Setu Webinars by NIPGR

“Plant-Microbe Symbiosis: An Avenue to Sustainable Agriculture”

Press- Note

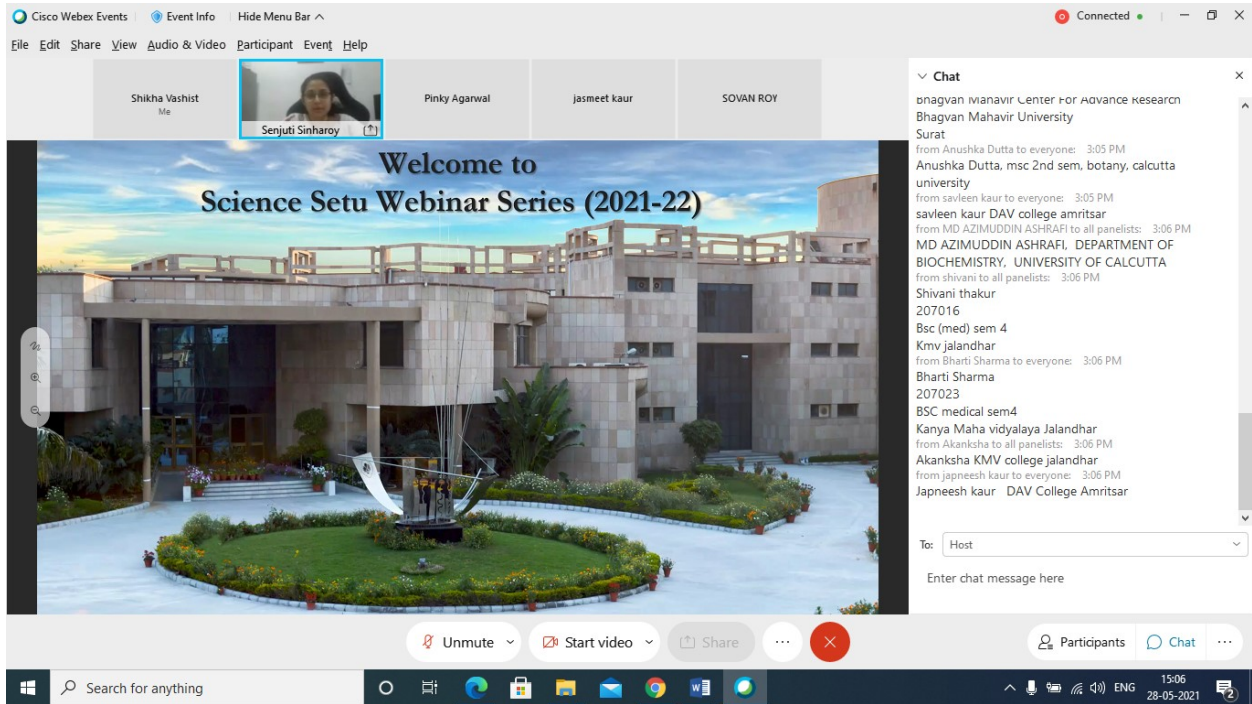
Date: 28-05-2021, Thursday

Resource person: Dr. Senjuti Sinharoy Scientist IV, NIPGR

The Department of Biotechnology, Government of India, has planned “Science Setu” as a virtual platform to connect research Institutes with undergraduate students. Under this, our college has been assigned to National Institute of Plant Genome Research (NIPGR), New Delhi. NIPGR is an autonomous institution aided by the Department of Biotechnology. Research at NIPGR focuses on functional, structural, evolutionary and applied genomics of plants, including crop plants. Through the Science Setu program, our students and faculty virtually connect with NIPGR, New Delhi and got to know about the multifarious kinds of plant based research. It is a unique opportunity for science students at undergraduate level to get an exposure to high-level research.

Dr. Pinky Agarwal, Scientist, NIPGR gave welcome note on this event. Resource person: Dr. Senjuti Sinharoy Scientist IV, NIPGR, began her talk by giving an introduction to the mechanism of symbiosis. She discussed about the early evolution of land plants and their impact on animal evolution. She explain the evolution of arbuscularmycorrhizal symbiosis as well as root nodule symbiosis. She stressed about the common signaling pathway that control AM symbiosis across the plant lineage. She explained about common toolkit that has been used for the AM symbiosis and Root nodule symbiosis. She describe the Nitrogen –Fixing Clade: depicting the phylogenetic relation of Nodulating Plant Species. She focused on the process of root nodule symbiosis by citing five step mechanism and explain whole process under these steps. With the help of a small video she explained symbiosome formation in model legume Medicago. She discussed the discoveries took place over the years, and the path taken by scientists to engineer root nodule symbiosis to make cereal fix their nitrogen from the air. In the end, Dr. Sinharoy described the research going on in her lab, and how to understand the tremendous diversity that exists among the infection mechanism, nodule structure, and nitrogen fixation efficiency among nodules. She

conclude her talk. She concluded her talk by citing scope for research in the field of symbiosis and how scientists can use it to engineer in non-fixing crops. Faculty of Science and total 50 science students from KanyaMahaVidyalaya, Jalandhar attended the event. Dr. Amarjeet Singh, Scientists, NIPGR attended the questions of the participants and gave vote of thanks. It was an intellectual and exciting experience for all the participants.



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Shikha Vashist Me Senjuti Sinharoy Pinky Agarwal jasmeet kaur Aashish Ranjan

Plant-microbe symbiosis
an avenue to sustainable agriculture

Symbiosis = Mutually feeding

sugar mineral nutrients

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15:10 28-05-2021

Chat

Princy Grover,KMV to all panelists: 3:08 PM
Princy,Department of Biotechnology,KMV Jalandhar

MD AZIMUDDIN ASHRAFI to everyone: 3:08 PM
MD AZIMUDDIN ASHRAFI, PHD SCHOLAR,
DEPARTMENT OF BIOCHEMISTRY, UNIVERSITY OF
CALCUTTA

Yogita Rana to all panelists: 3:08 PM
yogita Rana msc botany 4 sem Kmv dg jindr

Simran Preet Kaur to everyone: 3:08 PM
Simran Preet Kaur, B.Sc (H) Microbiology, Ram Lal
Anand College, University of Delhi

Meet Makwana to all panelists: 3:08 PM
Meet Makwana
Bsc (H) Microbiology (1st Year)
Ram Lal Anand College
University of Delhi

shuaib to everyone: 3:09 PM
Meerut college Meerut

rohan gupta to all panelists: 3:10 PM
Rohan gupta
Bsc Biotech final year
DAV college amritsar

To: Host

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Layout

Symbiosis

Viewing Senjuti Sinharoy's a...

Symbiosis (sym- same, bio- living) is any relationship where two or more species live closely together.
There are three types of symbiosis:

Mutualism
(+/+)

Commensalism
(+/0)

Parasitism
(+/-)

Sylvia freeman

Image source: By Sylvia Freeman

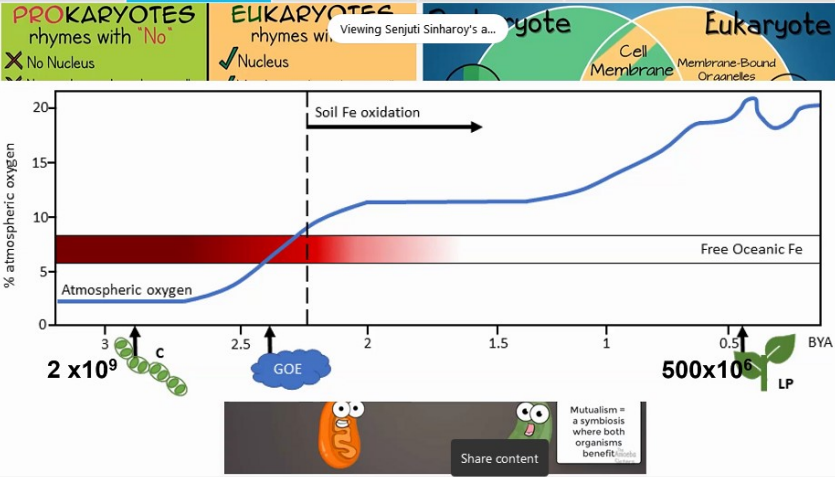
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15:11 28-05-2021

Participant list: Shikha Vashist, Senjuti Sinharoy, Pinky Agarwal, jasmeet kaur, SOVAN ROY, Aashish Ranjan. Includes a 'Layout' button.



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Layout

Viewing Senjuti Sinharoy's a...

Land plants arose earlier than thought—and may have had a bigger impact on the evolution of animals

Morris et al., (2018) PNAS

Paleozoic Era

543 Million 248 Million 66 Million 0 Years Ago

Chase Studios

Permian Period 251 299
Carboniferous Period 318 359
Devonian Period 416
Silurian Period 443
Ordovician Period 488
Cambrian Period 542

Reptiles Insects Land plants Fish Animals with Shells

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A guide to prehistoric plants

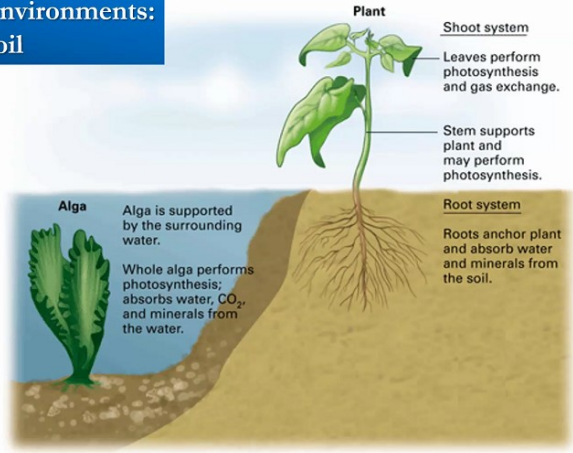
- Sphenopsida "Horse Tails"
 - Lack Seeds (sexual fertilization requires water)
 - Common in Triassic and Jurassic, rarer in Cretaceous
- Ferns
 - Lack Seeds (sexual fertilization requires water)
 - Common throughout Mesozoic
- Gymnosperms "naked seeds"
 - Have seeds (wind pollinated)
 - Common in Jurassic and Cretaceous

<https://www.youtube.com/watch?v=DSwqeTNCg8I>

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A plant lives in two environments: Air and Soil

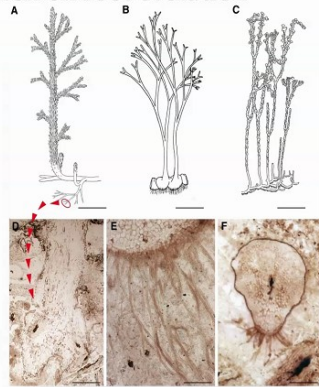


<https://bodell.mtchs.org/OnlineBio/BIOCD/text/chapter19/concept19.1.html>

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Geological sites of exceptional fossil preservation are becoming a focus of research on root evolution



Slide PB SC 3137 from the Natural History Museum, London

Paul and Strullu-Derrien (2014) Plant Physiology

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Participant list: Shikha Vashist (Me), Senjuti Sinharoy, Pinky Agarwal, jasmeet kaur, SOVAN ROY, Aashish Ranjan. Includes a 'Layout' button.

Slide content: **Arbuscular Mycorrhizal** (with micrograph of roots and orange arrows), **Symbiosis** (with micrograph of green symbionts in red cells), and a small 'Viewing Senjuti Sinharoy's a...' window.

Webex controls: Unmute, Start video, Share, Participants, Chat.

Participant list: Shikha Vashist (Me), japneesh kaur, Senjuti Sinharoy, Pinky Agarwal, jasmeet kaur, SOVAN ROY.

Slide content: **Liverwort *Marchantia* gametophyte colonized by glomeromycete endosymbionts**. Includes three micrographs labeled **a**, **b**, and **c**. Citation: Humphreys et al., (2010) Nature Communication.

Webex controls: Unmute, Start video, Share, Participants, Chat.

Shikha Vashist Me | japneesh kaur | **Senjuti Sinharoy** | Pinky Agarwal | jasmeet kaur | SOVAN ROY

A common signalling pathway control AM symbiosis across the plant lineages

~480 Mya
~150 Mya
~120 Mya
~110 Mya

Marchantia Oryza Petunia Helianthus Populus Medicago

Rich et al., (2021) Science

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Non-Mycorrhizal Plants

Viewing Senjuti Sinharoy's a...

Plant life cycle

Non-host RAM AM

Reported to develop both AM and non-host phenotypes in associated non-host plants

Legend:
 ■ Genome sequences published
 ■ Genome sequencing in progress
 ■ Genome sequencing not started

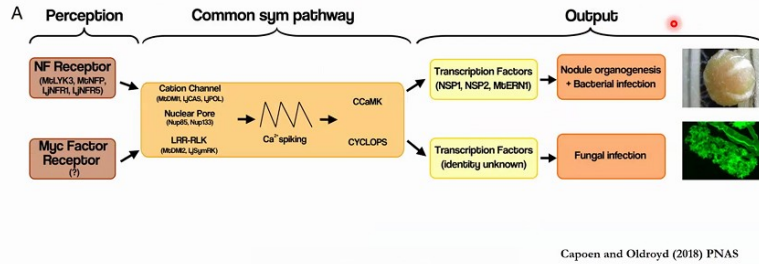
Cosme et al., (2018) Trend in Plant Science

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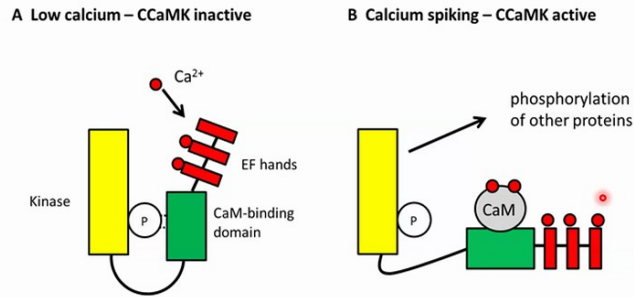
Common toolkit that has been used for the AM symbiosis and Root nodule Symbiosis



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CCaMK: work like a protein switch and activate AM or RNS



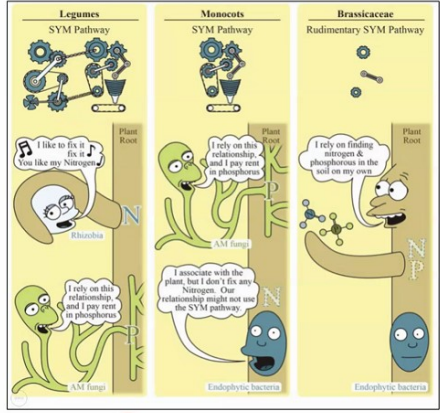
<https://plantscientist.wordpress.com/2014/01/09/ccamk-a-protein-switch-in-plant-microbe-symbioses/>

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Monocots are genetically more-closer to legumes than majority of Brassicaceae – from the point of view of Symbiosis



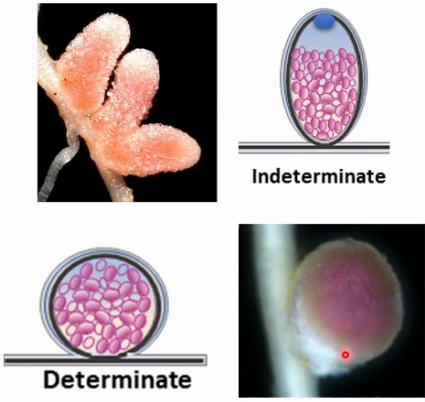
Modified from Venkateshwaran et al., (2014) Principles of Plant-Microbe Interactions

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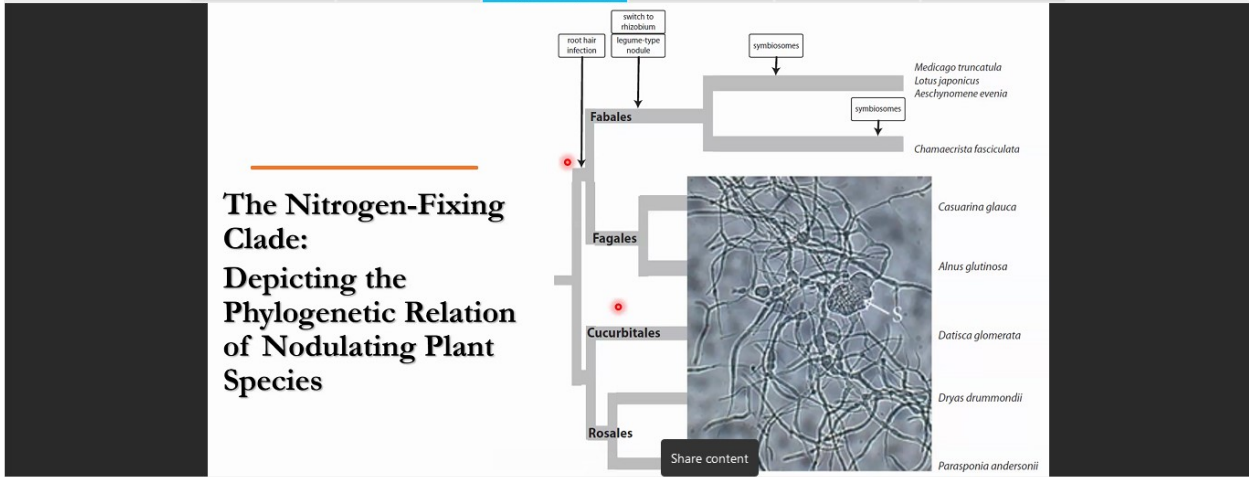
Shikha Vashist Me | japneesh kaur | **Senjuti Sinharoy** | Pinky Agarwal | jasmeet kaur | SOVAN ROY

Root Nodule Symbiosis



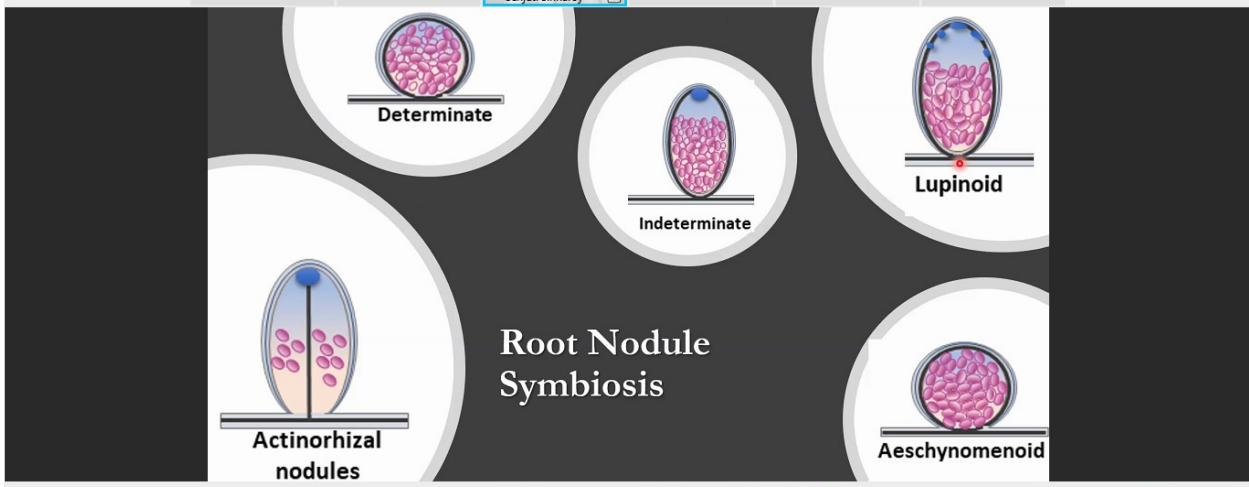
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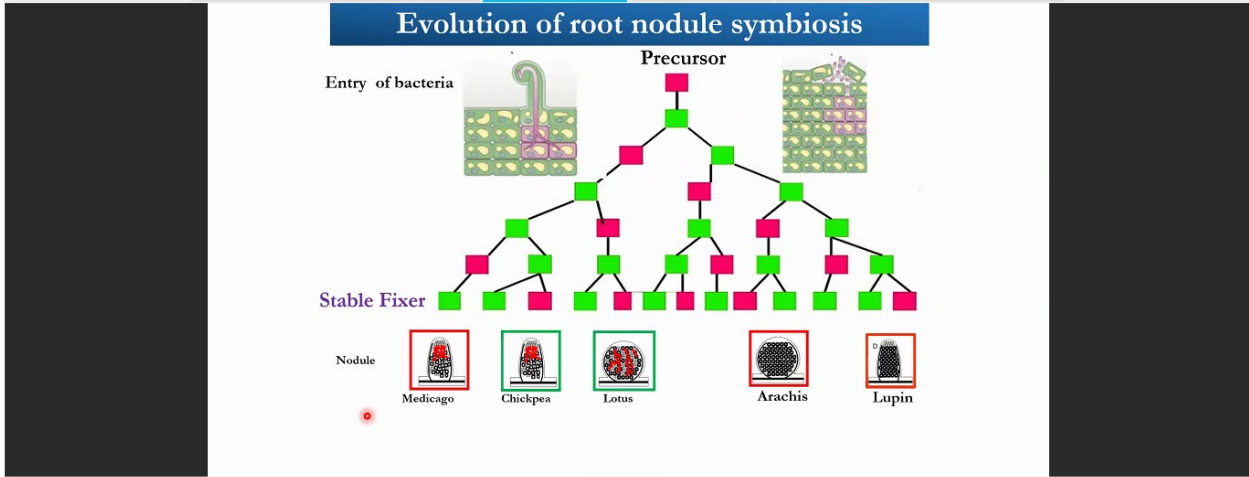
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1. Recognition of friend (Symbiont)

5. So much diversity exist among nodule forming legume and their Nitrogen Fixation efficiency

3. Root De-differentiation that is "Nodule Organogenesis"

4. How to control defense response and accommodate symbiont in a small space ?

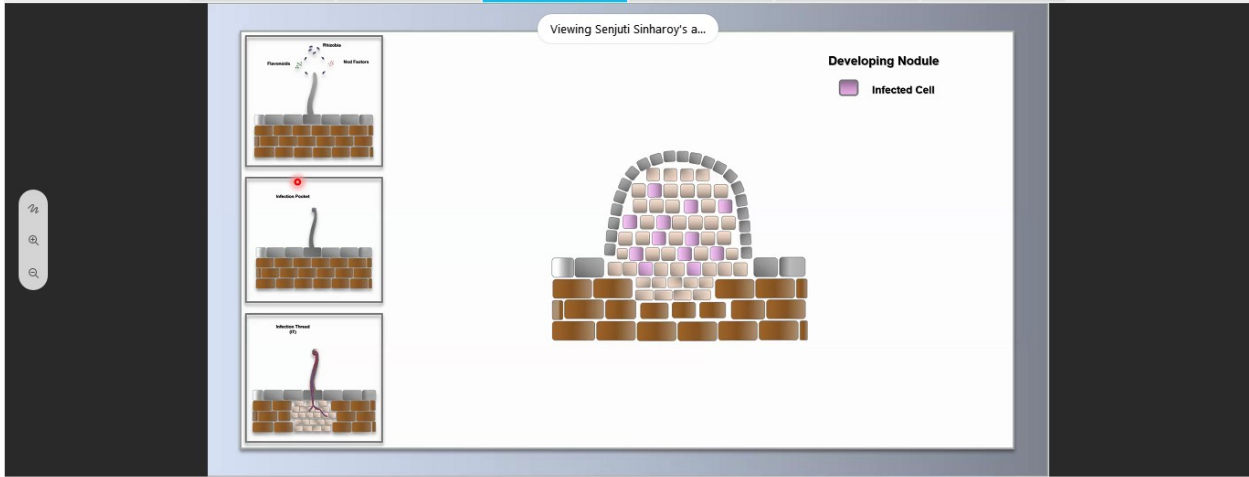
2. Plant need to maintain nodule number; can't drain out all sugar -- AON

Steps of Root Nodule Symbiosis

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Recognition, Invasion and New Organogenesis

2. Plant need to maintain nodule number; can't drain out all sugar -- AON

Soil Nitrogen

Shoot Har1

epidermis

cortex

Cell divisions

Cytokinin → LHK1/MCRE1

Root susceptibility

Gene expression (NIN)

infection

Symbiotic bacteria

Factor

Cap²⁺

CCaMK

NSP1

NSP2

ERN

HK

RRs

RRs/NSP2/NSP1/ERN

NIN/ENOD40

Trends in Plant Science 2008 13115-120

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1. Recognition of friend (Symbiont)

Pathogenesis and symbiosis: two sides of the same coin

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Chimeric receptors dominant for chitin and Nod factor signaling

A

B

Bozsoki et al., (2020) Science

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How legumes control which rhizobium they are going to allow to be its Symbiont—The molecular concept of cross inoculation group

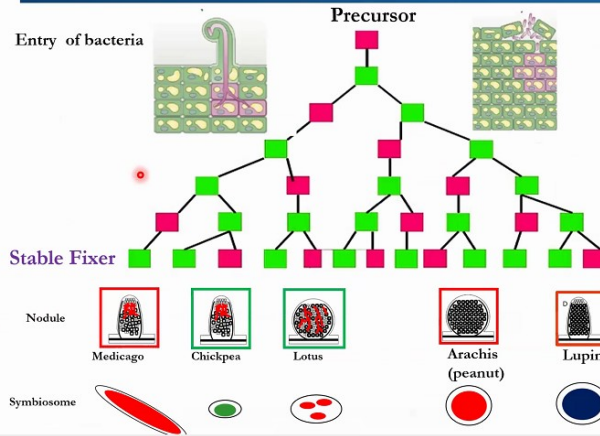
Rhizobium Spp.	Cross Inoculation Grouping	Legume Types
R. leguminosarum	Pea group	Pisum, Vicia, Lens
R. phaseoli	Bean group	Phaseolus
R. trifolii	Clover group	Trifolium
R. meliloti	Alfalfa group	Melilotus, Medicago, Trigonella
R. lupini	Lupini group	Lupinus, Orinthopus
R. japonicum	Soybean group	Glycine
Rhizobium sp.	Cowpea group	Vigna, Arachis

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Evolution of root nodule symbiosis

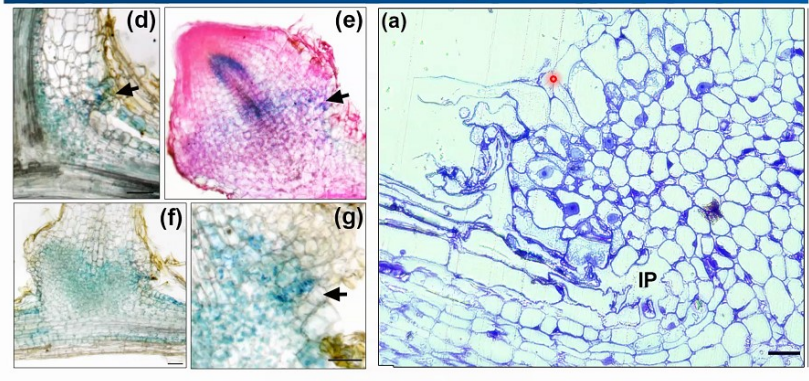


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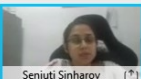
Shikha Vashist Me | japneesh kaur |  Senjuti Sinharoy (*) | Pinky Agarwal | jasmeet kaur | SOVAN ROY

Nodule induced Glycosyle hydrolase control crack invasion of rhizobium in peanut

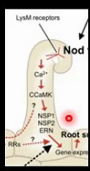
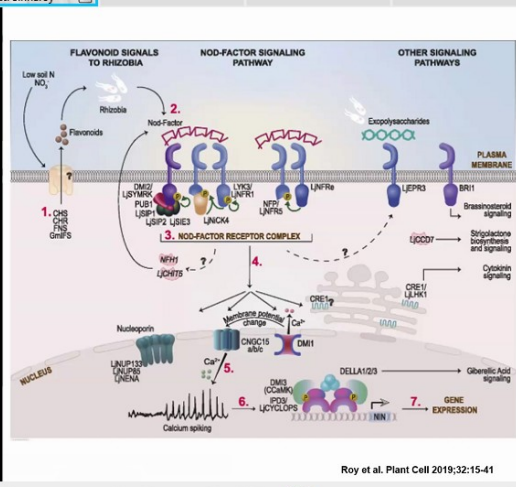


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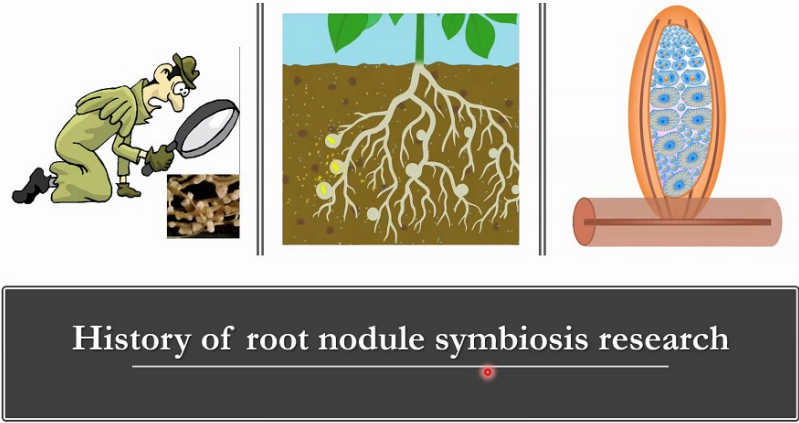
A glimpse of the complexity—early signaling of rhizobia-legume symbiosis

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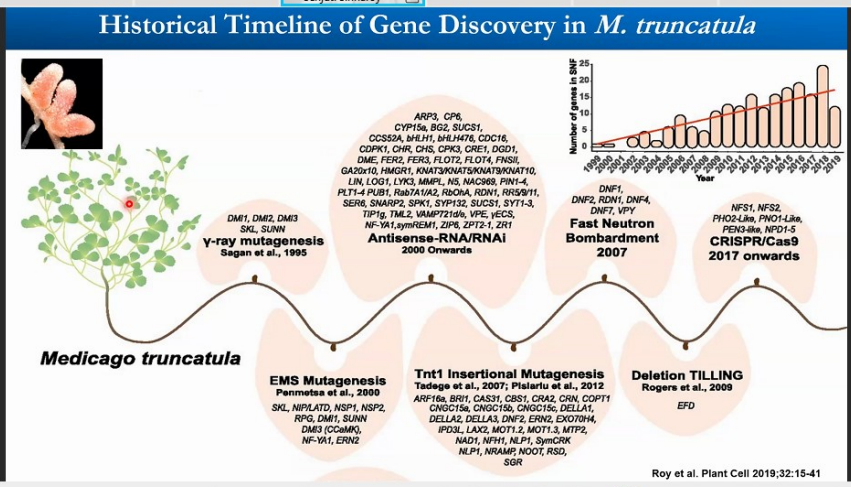


History of root nodule symbiosis research

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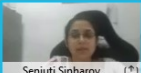
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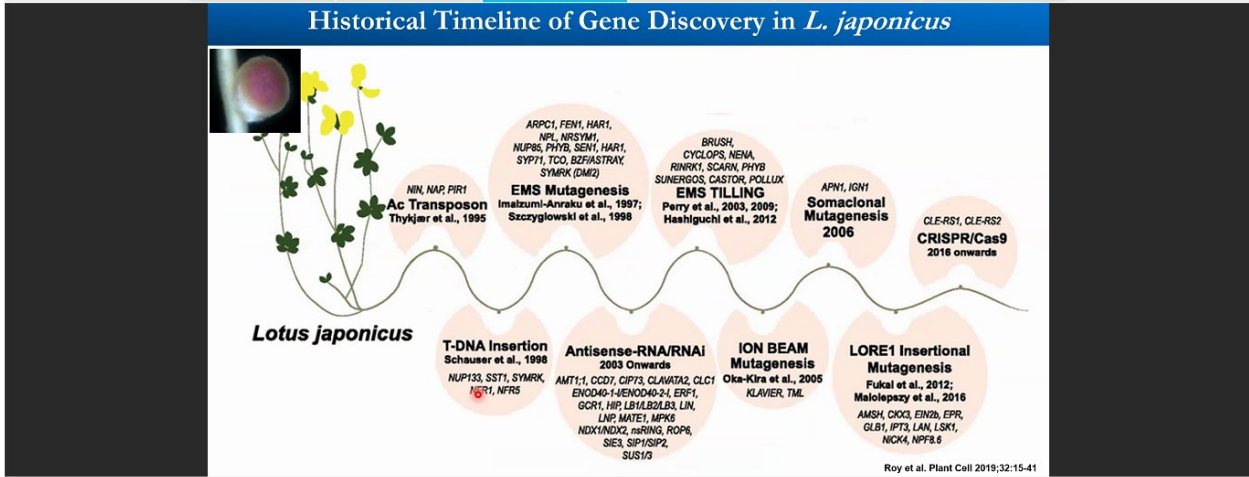
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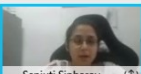
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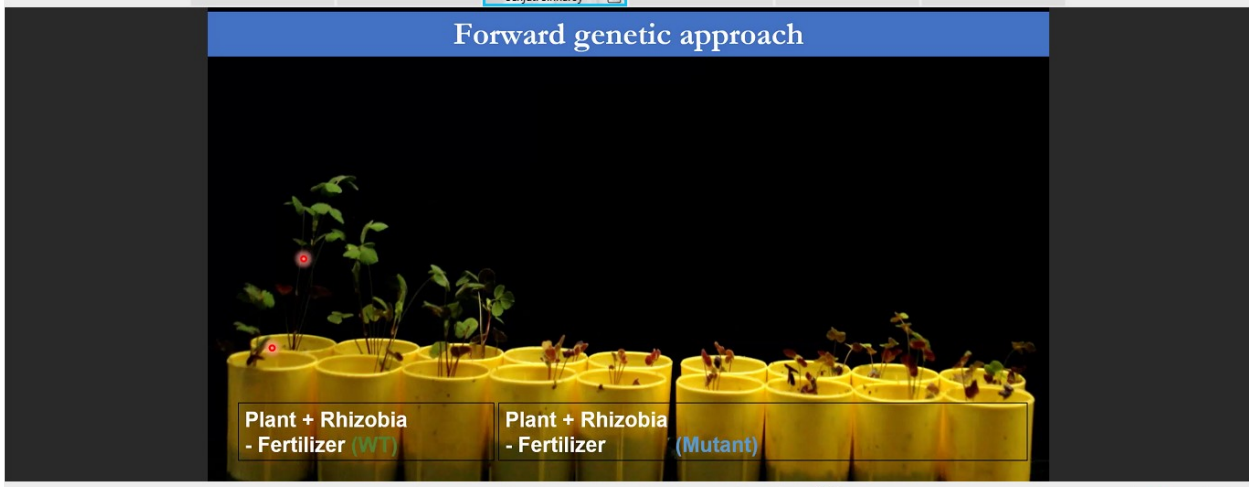
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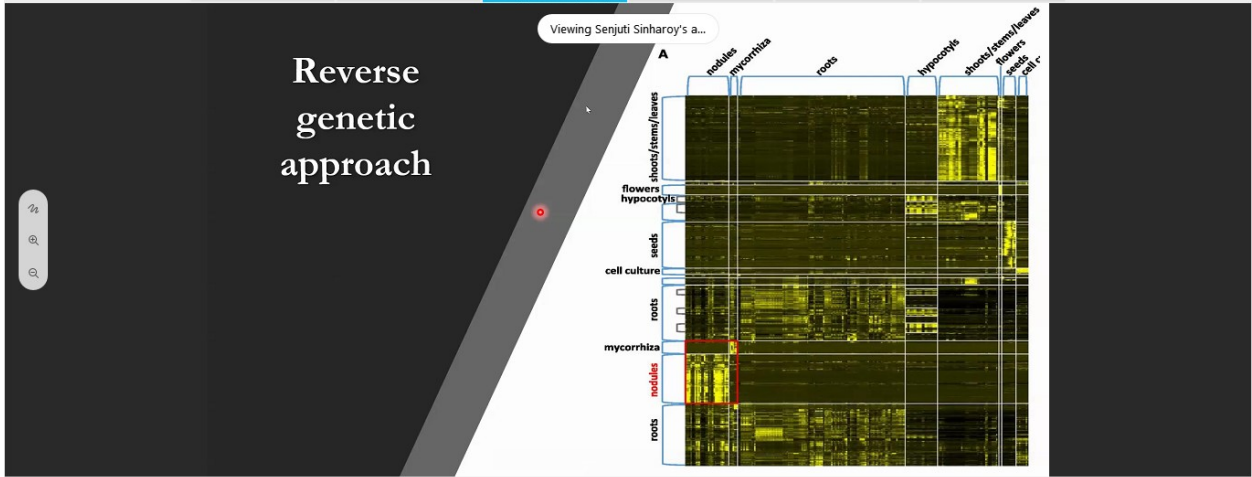
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Reverse genetic approach

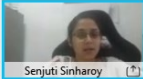
I know the gene!
But it **might not have a phenotype!**

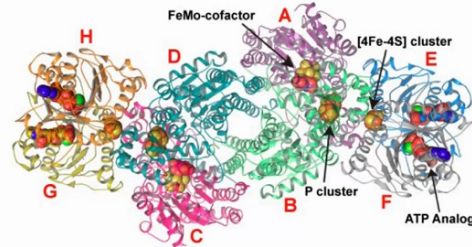
The illustration shows a person standing at a signpost with two arrows: a blue arrow pointing left labeled 'FAILURE' and a red arrow pointing right labeled 'SUCCESS'. The person is looking towards the 'FAILURE' arrow.

The photograph shows several yellow pots containing plants. The pots are arranged in two rows. The first row is labeled 'Plant + Rhizobia - Fertilizer (WT)' and the second row is labeled 'Plant + Rhizobia - Fertilizer (Mutant)'. The plants in the 'WT' row appear to be growing better than those in the 'Mutant' row.

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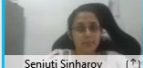
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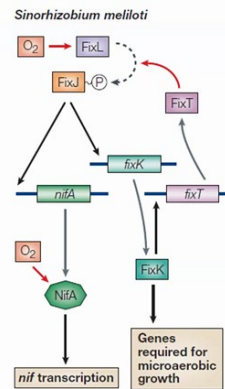
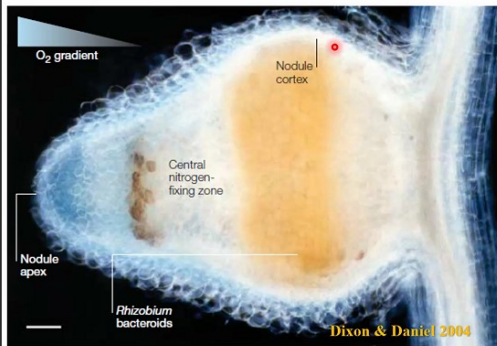
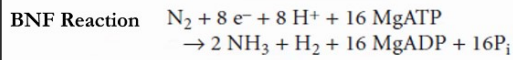


Bacterial Nitrogenase is super sensitive to oxygen

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Biological Nitrogen fixation is oxygen sensitive

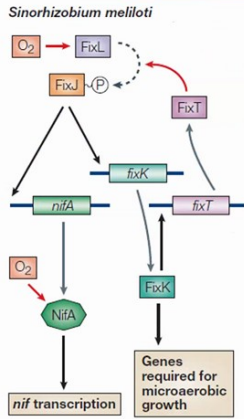


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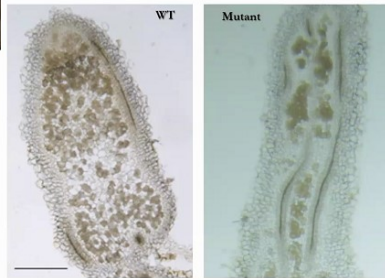
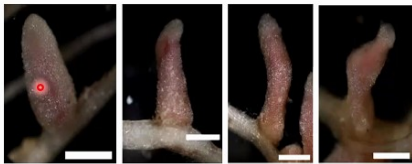
Symbiotic Nitrogen fixation



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How nodule vascular bundle development evolved ?



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- 1. Recognition of friend (Symbiont)
- 2. Plant need to maintain nodule number; can't drain out all sugar -- AON
- 3. Root De-differentiation that is "Nodule Organogenesis"
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- 5. So much diversity exist among nodule forming legume and their Nitrogen Fixation efficiency

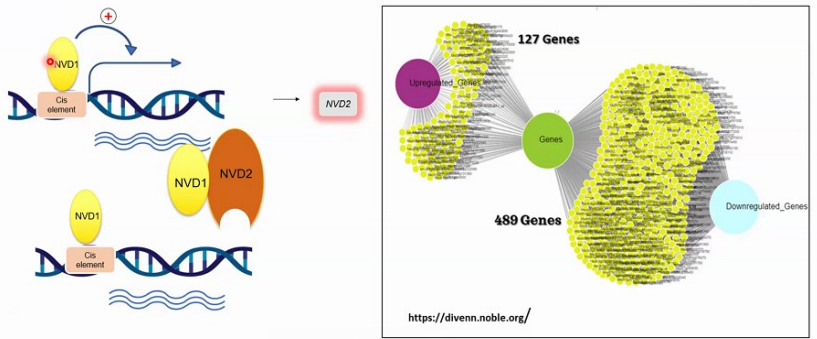
Steps of Root Nodule Symbiosis

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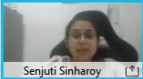
Shikha Vashist Me | Abhilash Jeas George | Senjuti Sinharoy | Pinky Agarwal | jasmeet kaur | SOVAN ROY

Proposed Hypothetical Model

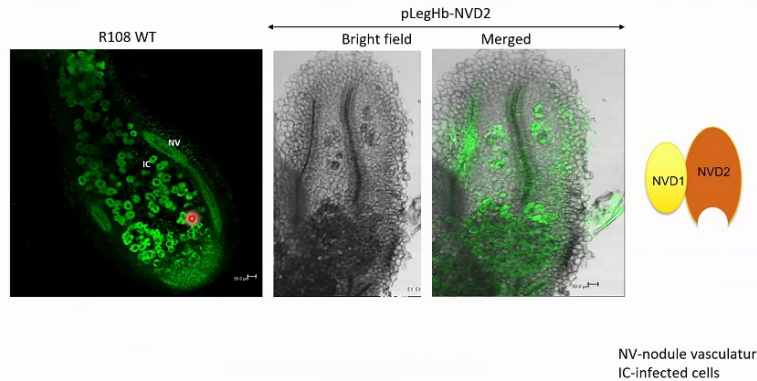


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Distorted vasculature phenotype in *pLegHb-NVD2* transformed nodule

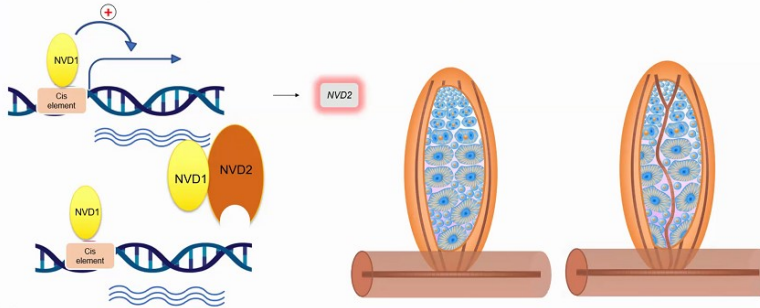


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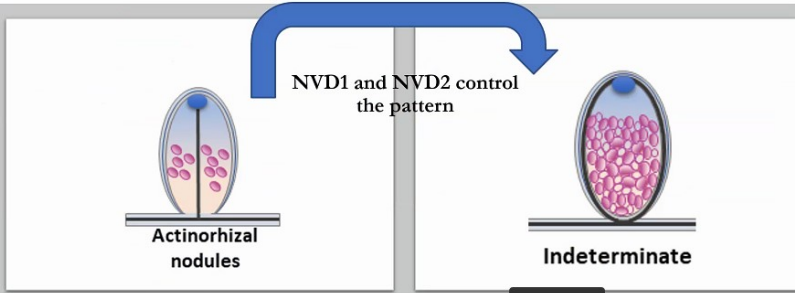
How NVD1 and NVD2 control nodule vascular bundle development



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Participant list: Shikha Vashist (Me), Abhilash Jeas George, Senjuti Sinharoy (Active), Pinky Agarwal, jasmeet kaur, SOVAN ROY. Includes a 'Layout' button.

NVD1 and NVD2 control the peripheral vasculature: But what triggered the switching ?

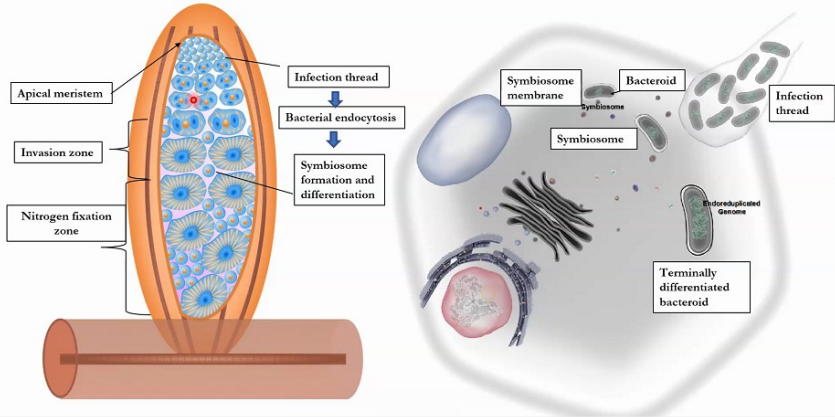


More options

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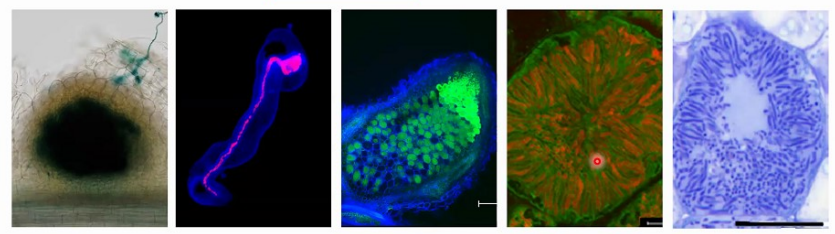
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Symbiosome Formation in *Medicago truncatula*



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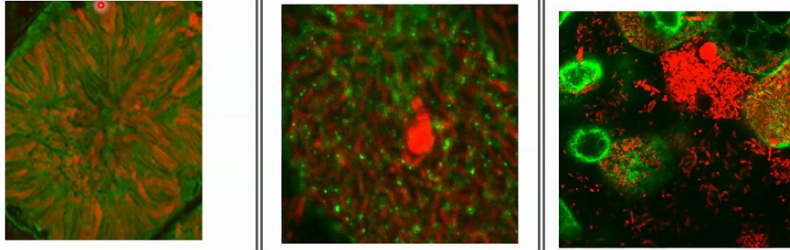


Different steps of nodule development : an observation under the microscope

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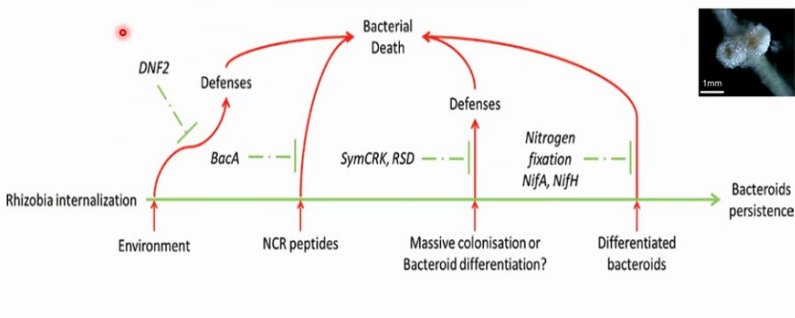
4. How to control defense response ?

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Bacteroid death is prevented by multiple actors acting successively

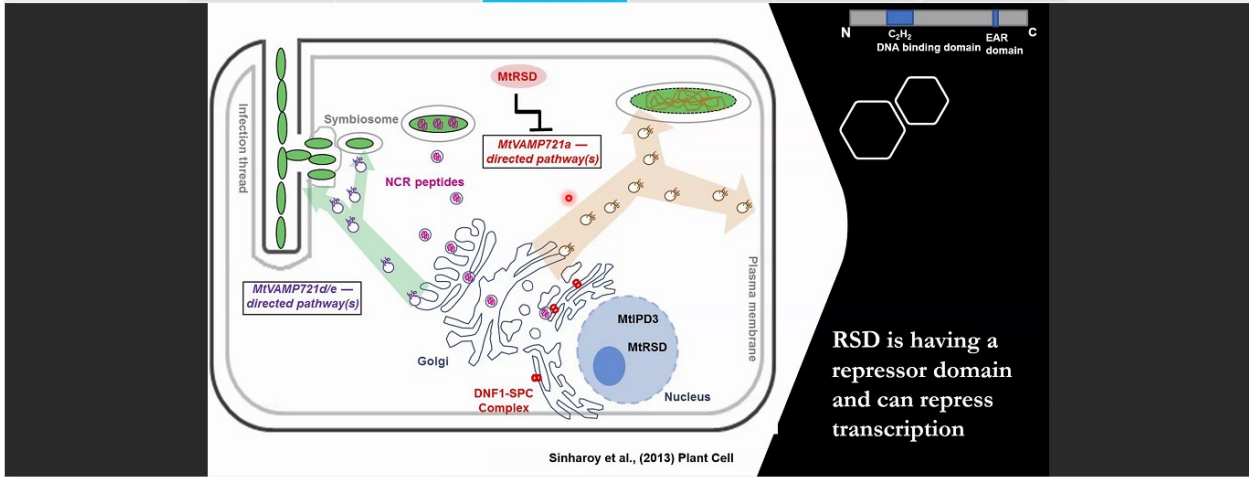


Berrabah et al., (2015) Journal of Experimental Botany

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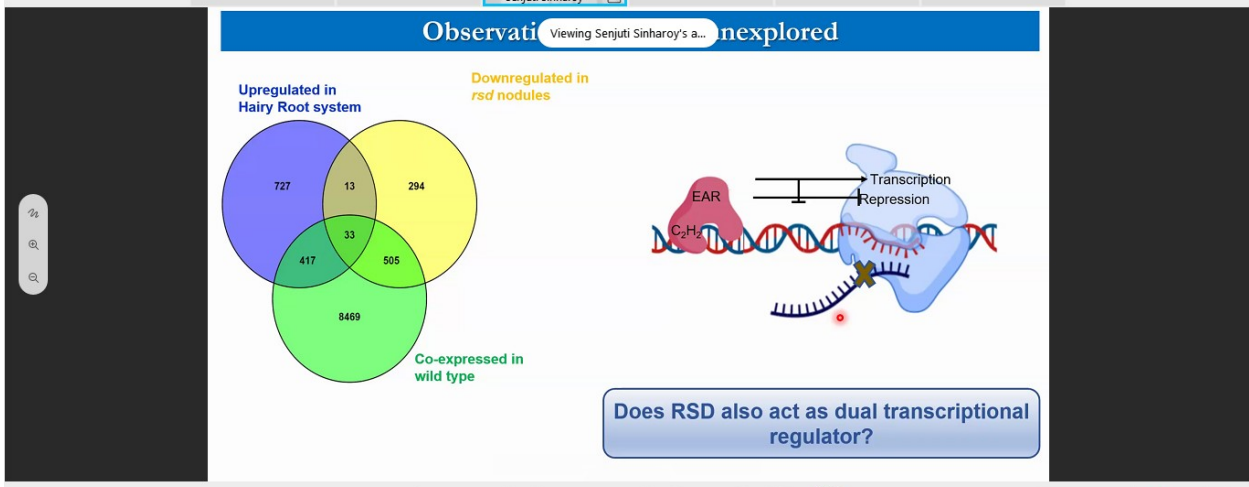
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Shikha Vashist Me | Abhilash Jeas George | Senjuti Sinharoy (↑) | Pinky Agarwal | jasmeet kaur | SOVAN ROY



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Shikha Vashist Me | Abhilash Jeas George | Senjuti Sinharoy (↑) | Pinky Agarwal | jasmeet kaur | SOVAN ROY | Layout

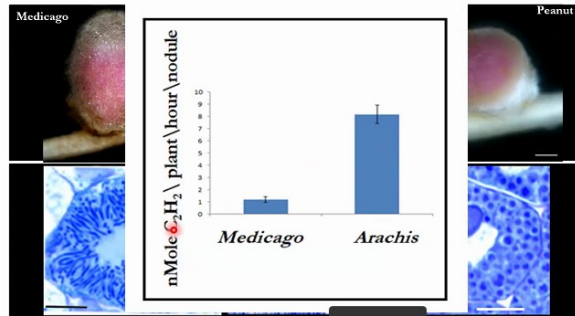


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Shikha Vashist Me | Abhilash Jeas George | Senjuti Sinharoy | Pinky Agarwal | jasmeet kaur | SOVAN ROY

Is regulation of symbiosome development behind legumes differential nitrogen fixation ability ?



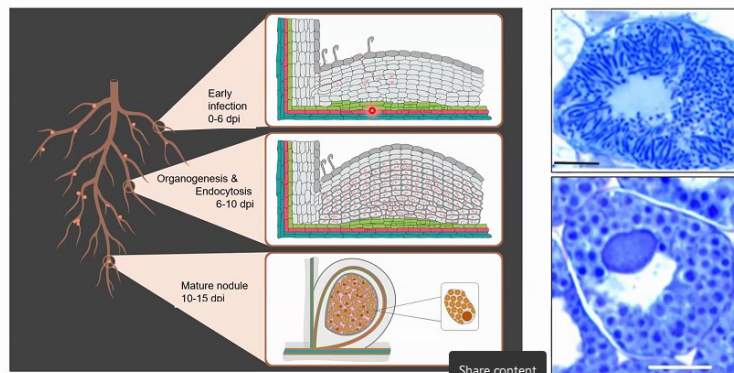
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Contrasting Nodulation Features of Medicago & Arachis



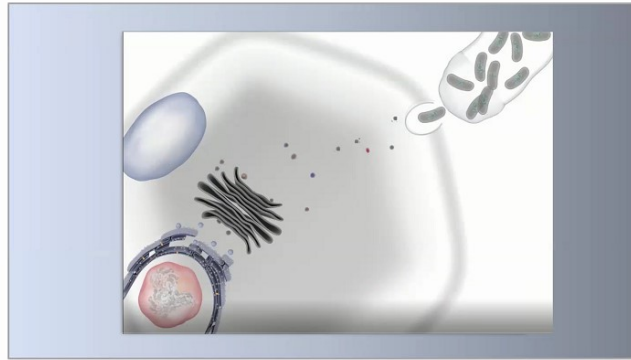
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Symbiosome formation in model legume *Medicago*



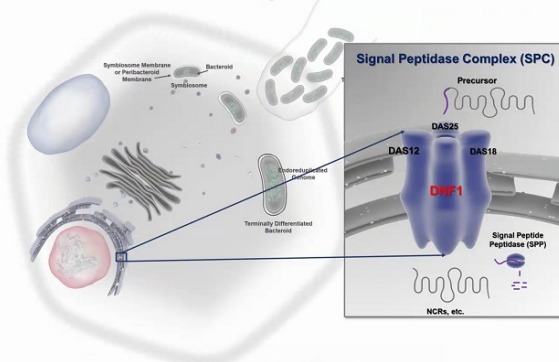
Created by Mr. Bikash Raul

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DNF1 complex deliver proteins and peptides towards symbiosome! Yes there is a dedicated protein trafficking pathway towards symbiosome

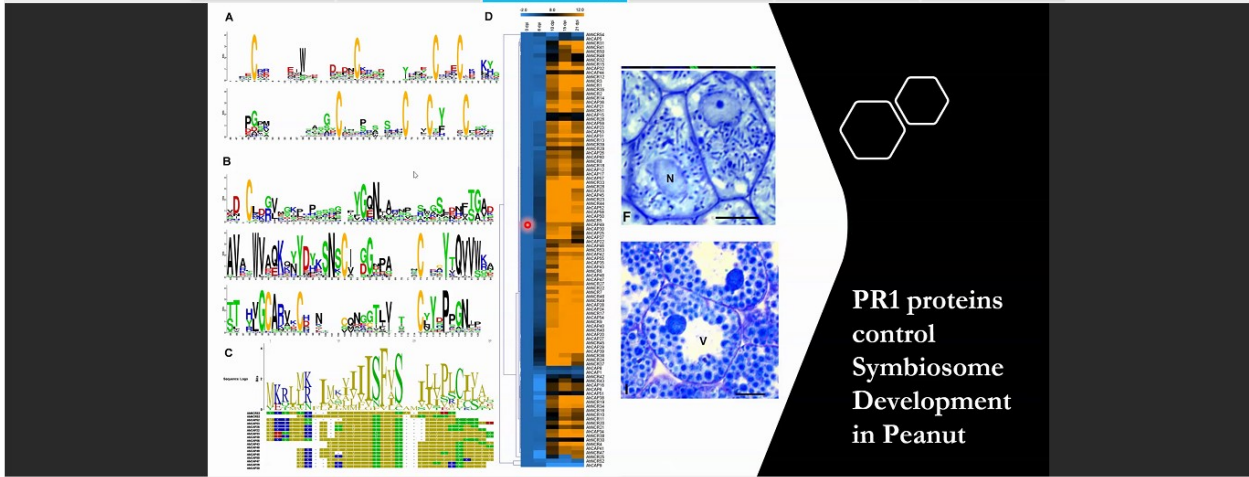


Wang et al., Science, 2010

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Shikha Vashist Me Abhilash Jeas George Senjuti Sinharoy (*) Pinky Agarwal jasmeet kaur SOVAN ROY



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Shikha Vashist Me Abhilash Jeas George Senjuti Sinharoy (*) Pinky Agarwal jasmeet kaur SOVAN ROY

Be Patient Cereals !

Legumes
Common SYM pathway

Monocots
Common SYM pathway

Brassicaceae
Rudimentary SYM pathway

Modified from Venkateshwaran et al., (2014)
Principles of Plant-Microbe Interactions

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Shikha Vashist Me Amarjeet Singh jasmeet kaur

Viewing Serjuti Sinharoy's a...

Document Recovery

Science Setu 2021_Serjuti...

Thank you

Slide 80 of 85

Chat

SOURAV PAL
B.sc(hons.) Microbiology
1year student , Ram Lal Anand College
Delhi University
from jasnoor kaur -207130 to all panelists: 3:07 PM
jasnoor kaur , bsc medical Semester-06, kmv jalandhar.
from Aniruddho Das to everyone: 3:07 PM
Aniruddho Das, JRF, Calcutta University
from jasmeet kaur to all panelists: 3:07 PM
jasmeet kaur 4504 bsc biotech sem 2 dav college
amritsar
from shivani to everyone: 3:07 PM
Shivani thakur
207016
Bsc (med) sem 4
Kmv jalandhar
from Ronak Patel to everyone: 3:08 PM
Ronak Patel
Teaching Faculty
Bhagwan Mahavir University , Surat
ronakpatel2992@gmail.com
from sheetal Ranaut to all panelists: 3:08 PM
good afternoon sir
sheetal Ranaut bsc med 3rd year from kanya maha
vidyalaya
from Princy Grover,KMV to all panelists: 3:08 PM

To: Host

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Shikha Vashist Me Abhilash Jeas George jasmeet kaur

Amarjeet Singh

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vidhlaya.
from Mahima to all panelists: 3:17 PM
Mahima Thakur
207006
bsc med sem 4
KANYA MAHA VIDHYALAYA, JALANDHAR
from Ravina Bisht to all panelists: 3:17 PM
Ravina
Bsc medical sem 6
Kanya Maha Vidyalaya
from Nishant to all panelists: 3:19 PM
Nishant, B.Sc. Life Science, first year, Shivaji College,
University of Delhi
from Aditi Naryal to all panelists: 3:19 PM
Aditi Naryal
B.Sc.(Med.) 6th Sem
KMV COLLEGE JALANDHAR
from cheshta to all panelists: 3:20 PM
cheshta bsc bt sem 5 dav college Amritsar
from Jahanvi to all panelists: 3:21 PM
jahanvi Bsc medical sem 6 kmv Jalandhar
from isha dhiman to all panelists: 3:22 PM
Isha Dhiman
BSCMED4
207001
from Arshdeep Kaur to all panelists: 3:22 PM
Arshdeep Kaur 207017 bscas maha vidyalaya

To: Host

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Amarjeet Singh

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Shikha Vashist Me SOVAN ROY Aashish Ranjan Abhilash Jeas George Akrit Kaur Gill

Pinky Agarwal

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Chat

from Abhilash Jeas George to everyone: 2:57 PM
Abhilash Jeas George
B.Sc. (Honours) Microbiology
II Year
Ram Lal Anand College, University of Delhi.

from Harleen Kaur to all attendees: 2:57 PM
Harleen Kaur, P.G. Department of Botany, KMV college, Jalandhar.

from Harleen Kaur to everyone: 2:58 PM
Harleen Kaur, P.G. Department of Botany, KMV college, Jalandhar.

from Shikha Vashist to host (privately): 2:58 PM
Good Afternoon to all...Shikha Vashist, A.P.,Kanya Maha Vidyalaya, Jalandhar

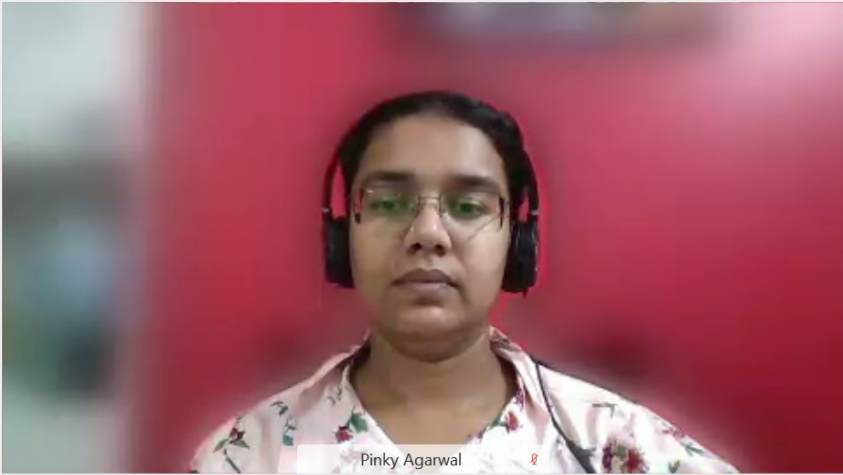
from Saumya Samridhi to all attendees: 3:00 PM
B.Sc. (Honours) Microbiology
Saumya Samridhi I Year
Ram Lal Anand College, University of Delhi.

from Dr. sandeep Kaur to all panelists: 3:03 PM
Good Afternoon everone... Dr. Sandeep Kaur, P.G. Department of Botany, Kanya Maha Vidyalaya, Jalandhar

from Deepika Vashistha to everyone: 3:03 PM
deepika vashistha assistant professor pg department of botany Kmv Jalandhar

To: Host

- Shikha Vashist Me
- SOVAN ROY
- Aashish Ranjan
- Abhilash Jeas George
- Akrit Kaur Gill



Chat

from Deepika Vashistha to everyone: 3:03 PM
deepika vashistha assistant professor pg department of botany Kmv Jalandhar

from Akrit Kaur Gill to everyone: 3:03 PM
Akrit Kaur Gill

from Dr. sandeep Kaur to everyone: 3:03 PM
Good Afternoon everone... Dr. Sandeep Kaur, P.G. Department of Botany, Kanya Maha Vidyalaya, Jalandhar

from Anavi Sareen to everyone: 3:03 PM
Anavi bsc med sem 6
KANYA MAHA VIDYALAYA JALANDHAR

from Anushree choudhary to everyone: 3:03 PM
Anushree choudhary phd scholar meerut college meerut

from Shefali Naryal to all panelists: 3:03 PM
Shefali Naryal
Bsc medical sem 4
207014
kmv jindhr

from Dr Shaweta Mohan to everyone: 3:03 PM
Dr Shaweta Mohan
Assistant Professor
BBK DAV College for Women
Amritt

To: Host

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