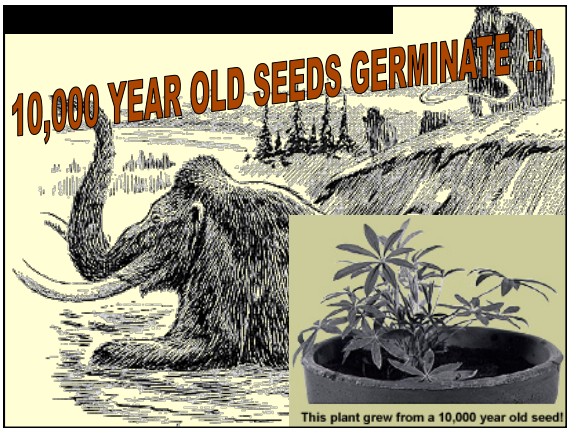


5 MAIN GROUPS OF PLANT HORMONES

REVIEW: SMALL MOLECULES PRODUCED IN ONE PART OF PLANT THAT MOVE TO ANOTHER PART AND PRODUCE A RESPONSE. WORK AT VERY SMALL CONCENTRATIONS

AUXINS

FOUND IN APICAL MERISTEM, EMBRYO OF SEEDS, YOUNG LEAVES, MOVES DOWN

CYTOKININS

GIBBERELLINS

ABSCISIC ACID

ETHYLENE

REVIEW OF AUXIN

many effects

PHOTOTROPISM

GRAVITROPISM?

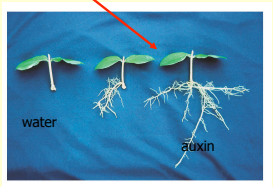
APICAL DOMINANCE

ROOT FORMATION IN CUTOFF SHOOTS

FRUIT DEVELOPMENT

ORIENTS THE PLANT (UPRIGHT)

2-4-D is an herbicide & a synthetic auxin

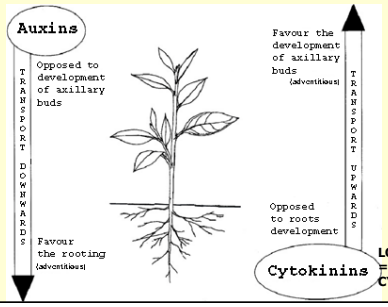


2. CYTOKININS

PROMOTE CELL DIVISION

FOUND IN ROOTS
MOVE UP TO SHOOTS THROUGH THE XYLEM
PROMOTE SHOOT GROWTH, LATERAL BUD GROWTH

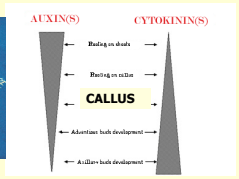
LOTS OF SHOOTS = LOTS OF AUXIN



LOTS OF ROOTS = LOTS OF CYTOKININS

RESPONSE DEPENDS ON RELATIVE CONCENTRATIONS OF 2 HORMONES

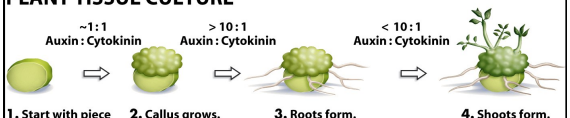
MORE ROOTS



MORE SHOOTS

USING HORMONES

PLANT TISSUE CULTURE



EQUAL AMOUNTS **HIGH AUXIN** **HIGH CYTOKININS**

AUXIN AND CYTOKININ USED IN PLANT TISSUE CULTURE : CLONING PLANTS

CLONING:

PRODUCING PLANTS THAT ARE GENETICALLY IDENTICAL TO THE PARENT PLANT

SOME PLANTS "CLONE" THEMSELVES IN NATURE

"CUTTINGS" ARE A FORM OF CLONING

GENETICALLY MODIFIED ORGANISM = GMO
GENETIC ENGINEERING: TO PRODUCE GMO'S, THE GENES ARE ACTUALLY **CHANGED**
THIS IS A DIFFERENT PROCESS!

3. GIBBERELLINS GA_3

IN YOUNG SHOOTS & SEEDS

MOVES THROUGH XYLEM & PHLOEM

STEM ELONGATION

INITIATES SEED GERMINATION

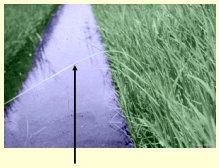
INVOLVED IN FLOWERING

Dwarf peas can't produce Gibberellins! So their stems do not elongate!

- **GIBBERELLIN TURNS SEED GERMINATION ON**
- **ABSCISIC ACID (ABA) TURNS OFF SEED GERMINATION**

THE GO HORMONE

DISCOVERY OF GIBBERELLINS



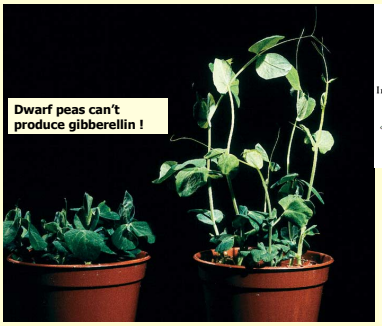
THIS PLANT HORMONE WAS FIRST DISCOVERED IN A FUNGUS!

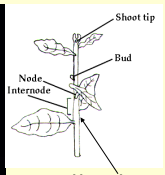
FOOLISH SEEDLING DISEASE IN RICE IS CAUSED BY A FUNGUS (called *Gibberella*) THAT PRODUCES GIBBERELLINS (A PLANT HORMONE!)

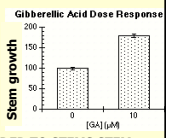
STEMS ELONGATE QUICKLY, BECOME WEAK AND FALL OVER

SINCE THEN WE HAVE FOUND GIBBERELLINS IN PLANTS !

GIBBERELLIN PROMOTES CELL ELONGATION AND RATES OF CELL DIVISION



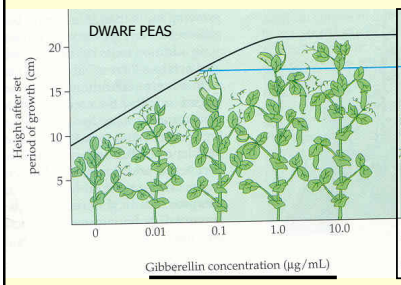


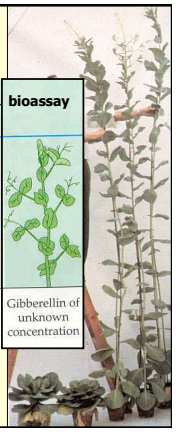


DWARF PEAS LACK GIBBERELLIN STEMS ARE SHORT

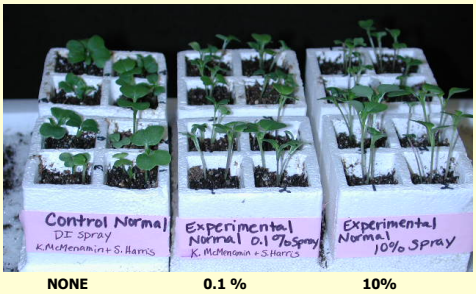
IF GIBBERELLIN IS ADDED TO STEMS STEM HEIGHT INCREASES IN DWARF PEAS

RESPONSE TO A HORMONE DEPENDS ON DOSE (HOW MUCH IS ADDED) = CONCENTRATION





GETTING CARRIED AWAY WITH GIBBERELLINS AND PEAS !



NONE **0.1 %** **10%**

SPRAY ON GIBBERELLIN AND MEASURE GROWTH RESPONSE !

HOW DO SEEDS KNOW WHEN TO GERMNINATE ?

What's the advantage ?

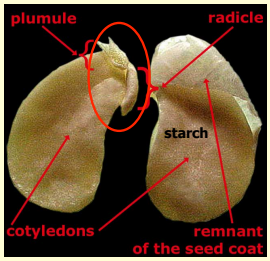
- **SOME SEEDS NEED COLD PERIOD BEFORE GERMINATING**
- **SOME SEEDS NEED A DRY PERIOD BEFORE GERMINATING**
- **SOME DESERT SEEDS NEED A LOT OF RAIN TO GERMINATE**

WHAT TRIGGERS SEED GERMINATION ?

ARE PLANT HORMONES INVOLVED ? HOW?

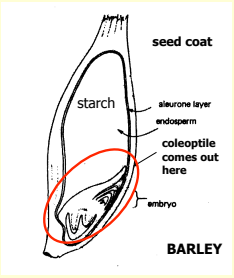
Seed structure

BEAN SEED: DICOT



Embryo = in the circles above
Cotyledons = starch = food for embryo

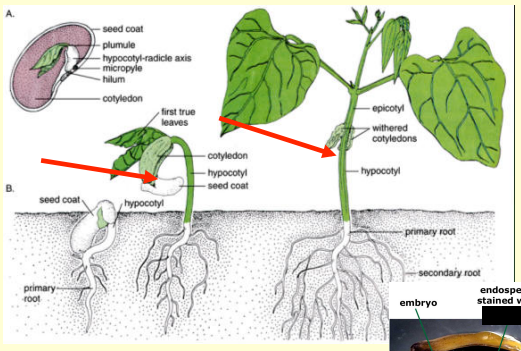
MONOCOT SEED

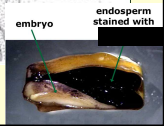


BARLEY

Embryo = in the circles above
Endosperm = starch = food for embryo

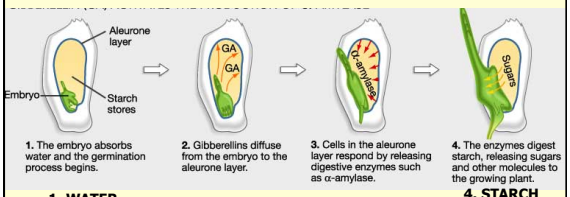
BEAN GERMINATION





STARCH IN THE SEED IS DIGESTED BY THE EMBRYO & USED FOR GROWTH

WHAT TURNS SEEDS ON ?



1. WATER → **2. GIBBERELLINS** → **3. AMYLASE** → **4. STARCH DIGESTED TO SUGAR**

AMYLOSE = STARCH

AMYLASE = ENZYME THAT DIGESTS STARCH

IODINE TEST FOR STARCH = BLUE IS A POSITIVE REACTION

SO WHY DOES A SEED NEED TO DIGEST STARCH?
DOESN'T IT MAKE IT'S OWN FOOD THROUGH PHOTOSYNTHESIS ?

REVIEW OF WHAT HAPPENS WHEN A SEED GERMINATES

1. **WATER TAKEN IN BY SEED, SEED SWELLS**
2. **GIBBERELLIN PRODUCED BY THE EMBRYO (I'M HUNGRY!)**
3. **GIBBERELLIN MOVES TO ALEURONE LAYER**
4. **ALEURONE LAYER PRODUCES AMYLASE (OK, THE FOOD IS COMING!)**
5. **AMYLASE MOVES TO THE STARCH & DIGESTS IT TO SUGAR (OK, HERE'S THE FOOD!)**
6. **EMBRYO USES THE SUGAR (UMMM....GOOD!)**
7. **EMBRYO MAKES LEAVES & PHOTOSYNTHESIS HAPPENS (I'LL MAKE MY OWN FOOD!)**

WATER (seed coat) → **GIBBERELLIN** (embryo) → **AMYLASE** (aleurone layer) → **DIGESTS STARCH** (endosperm) → **SUGAR** (embryo)

HOW MUCH GIBBERELLIN DOES A SEED PRODUCE?

ANOTHER TOOL FOR SCIENTIFIC TOOL BOX

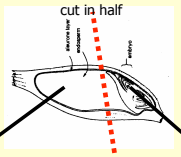
THE BIOASSAY:

A QUANTITATIVE EVALUATION
OF THE CONCENTRATION OF A SUBSTANCE
BY ASSESSING ITS EFFECT ON TISSUES, CELLS, ANIMALS

CAN WE USE A BIOASSAY TO FIGURE OUT HOW MUCH CAFFEINE IS IN A PARTICULAR SOFT DRINK ?

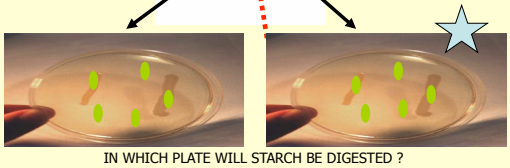
CAN WE USE A BIOASSAY TO DETERMINE **HOW MUCH GIBBERELLIN A SEED PRODUCES ?**

BARLEY SEED ON STARCH MEDIA, NO GIBBERELLIN ADDED



For a few days

endosperm half | **embryo half**



IN WHICH PLATE WILL STARCH BE DIGESTED ?

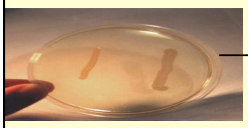
STARCH IS NOT DIGESTED HERE

EMBRYO PRODUCES GIBBERELLIN— AMYLASE MADE & DIGESTS THE STARCH. BUT HOW MUCH?

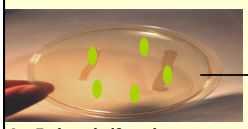
HOW CAN WE TELL IF THE STARCH IS DIGESTED?

PETRI DISH OF STARCH MEDIA

black color indicates starch is present



Iodine stains starch black



A. Embryo half produces gibberellin & starch is digested

AREA = = 3.14 x r²

Clear "halo"s = where starch is digested but how much is digested!

DO A BIOASSAY !

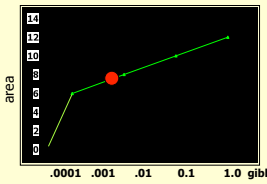
ADD KNOWN CONCENTRATIONS OF GIBBERELLIN TO STARCH MEDIA?

Add endosperm half = usually no digestion

area ~ starch digested

Enzyme dilution	x r² = Area 3.14 x r² = Area (mm²)
0.0001	6
0.001	7
0.01	8.5
0.1	10
1.0	12

uM



COMPARE TO AMOUNT DIGESTED BY THE EMBRYO HALF

AMOUNT OF STARCH DIGESTED IS PROPORTIONAL TO THE AMOUNT OF GIBBERELLIN PRESENT

4.ABSCISIC ACID (ABA):

ANOTHER PLANT HORMONE

- **ABSCISIC ACID TURNS OFF SEED GERMINATION**
- **GIBBERELLIN TURNS SEED GERMINATION ON**

- **MECHANISM: COMPETE FOR SAME BINDING SITES ON DNA**
- **SEED RESPONSE: DEPENDS ON THE PROPORTION OF GA:ABA**

WHAT ABOUT SEEDS IN THE DESERT?

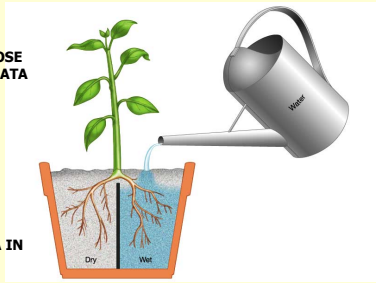
WHEN IT RAINS, ABA IS WASHED OUT OF THE SEEDS, AND IT GERMINATES ! GO SIGNAL!

ALSO PROMOTES LEAF DROP (ABSCISSION)

THE STOP HORMONE

ABA IN ROOTS CAN CLOSE STOMATA

2. CLOSE STOMATA



1. HIGH ABA IN DRY ROOTS

SIGNALS DROUGHT STRESS

ABA MOVES FROM ROOTS TO SHOOTS

patches

5. ETHYLENE

A GAS !

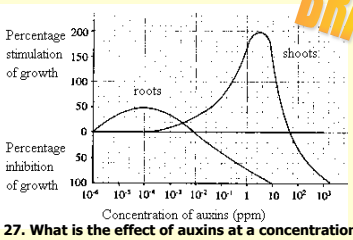
USUALLY A GROWTH INHIBITOR

HELPS RIPEN FRUIT

LEAF ABSCISSION, FRUIT DROP

INITIATION OF FLOWERING

BRAIN TEASER



27. What is the effect of auxins at a concentration of 10^{-2} ppm on the growth of roots and shoots?

A. Growth of roots is stimulated and growth of shoots is stimulated
B. Growth of roots is stimulated and growth of shoots is inhibited
C. Growth of roots inhibited and growth of shoots is stimulated
D. None of above