Effects of Environment on Phenotype

POLL:
Nature (Genes) primarily shapes who you are

POLL:
Nurture (environment) primarily shapes who you are

"Nature or Nurture?"

"Nature or Nurture?"

Pg 42

- The phenotype of a characteristic is basically determined by the gene(s) controlling that particular characteristic. However, environmental conditions to which an individual is subjected may affect gene expression.

- The product of a genotype is generally not a rigidly defined phenotype, but a range of phenotypic possibilities over which there may be variation due to environmental influence.

"Nature or Nurture?"

Pg 43

- An individual's phenotype is an outcome of complex interactions among its genes, enzymes and other gene products, and environmental factors.

"Nature or Nurture?"

Pg 43

Overall phenotype

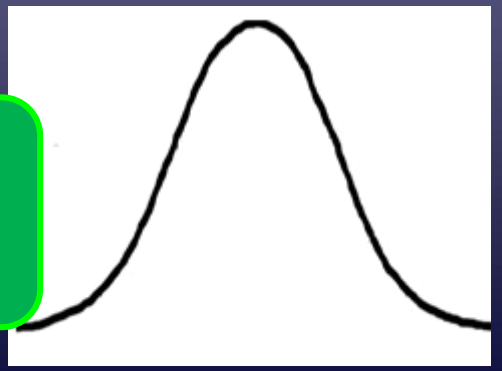
Proteins

Interaction

Environment

Genes

Range of phenotypes



"Nature or Nurture?"

The Neubauer study

Led separate lives

Identical twins separated when young during adoption

By Elyse Schein and Paula Bernstein

Twins reunited in 2004

Study results : Find out!

http://www.npr.org/templates/story/story.php?storyId=15629096

N.Y. / REGION

Peter B. Neubauer, 94, Noted Child Psychiatrist, Is Dead

By JEREMY PEARCE MARCH 3, 2008

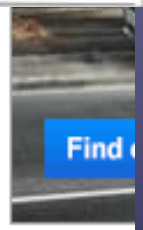
Dr. Peter B. Neubauer, a child psychiatrist and researcher who raised public alarms early on about the possible effects of television violence on the emotional development of children, died on Feb. 15 in Manhattan. He was

Twin studies

rmed by his family.

In 1960, as part of a C the issue, Dr. Neubauer contended ares in young viewers and lead to emotional problems. He sparred with another panel member, the Random House publisher Bennett Cerf, who defended television as an intellectual tonic. Dr. Neubaue displays of violence "underwater, over water, c could have only a malignant influence, especia of 4 to 7.

Not completed.



Results locked up in Yale until 2065

The Neubauer study

https://www.youtube.com/watch?gl=SG&v=0yTCShemS_0&hl=en-GB

Learning Outcome:

2(m) Explain, with examples, how the environment may affect the phenotype (including how temperature affects fur colour of Himalayan rabbits).

Write in notes

Gist of each case study

All organisms discussed are the same at genetic level

e.g. Same genotype

e.g. Same type of genes

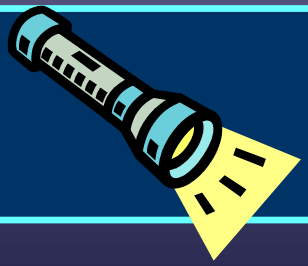
e.g. same # of sets of chromosome

Exposed to diff environmental conditions

Phenotype differs

What are some environmental factors which may affect phenotype?

Effects of Environment
on Phenotype

- **Temperature** 
- **Diet** 
- **Light** 

Effects of Environment

Effects of Temperature on Phenotype

1) Coat colour in Himalayan rabbits

- A Himalayan rabbit has a white body with black ears, nose, feet and tail.

extremities

Pg 43

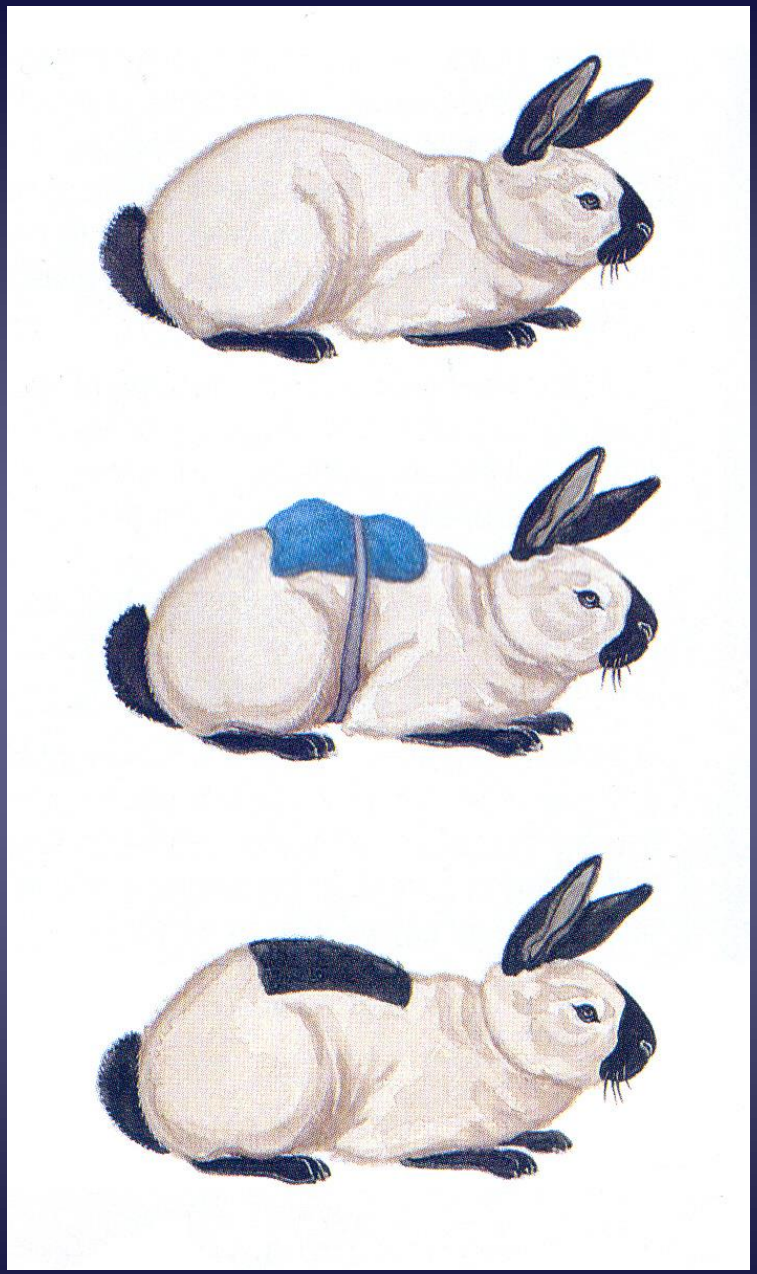
Effects of Environment

Effects of Temperature on Phenotype

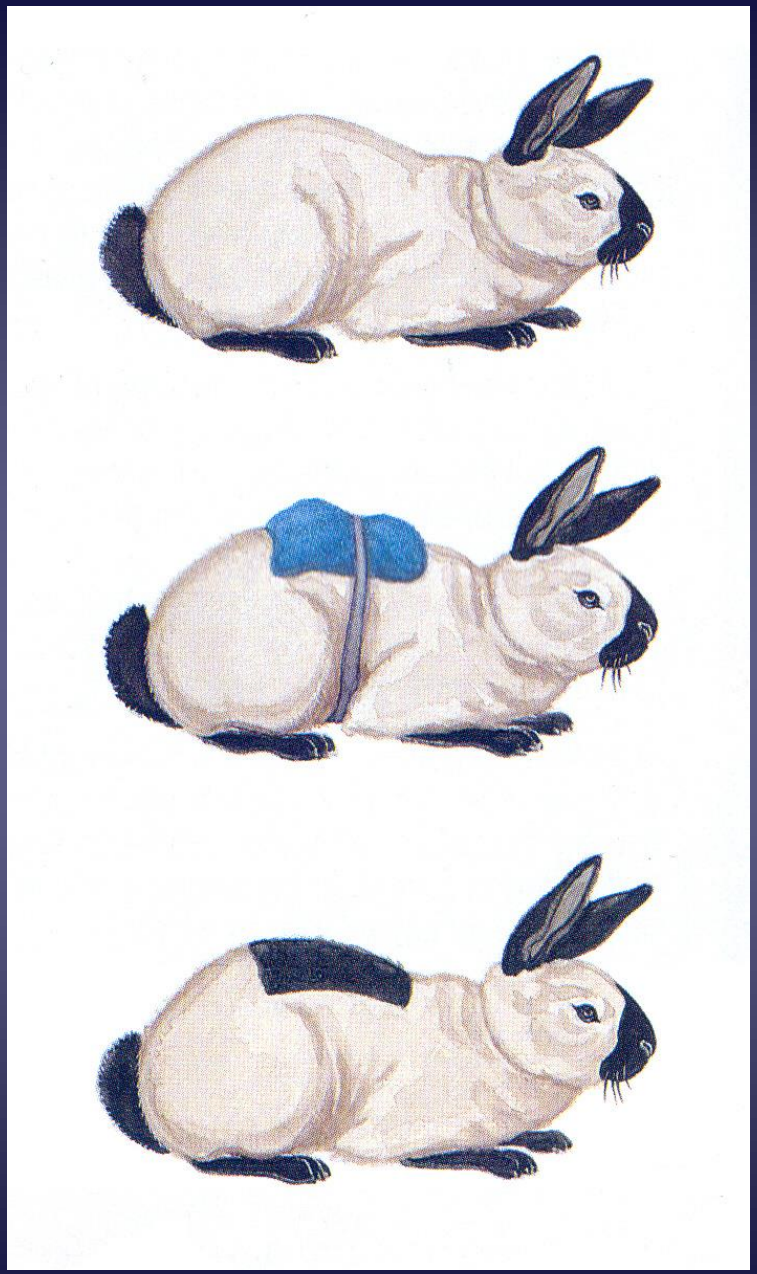
1) Coat colour in Himalayan rabbits

- A Himalayan rabbit has a white body with black ears, nose, feet and tail.
- Temperature affects the fur colour of Himalayan rabbits.

Pg 43



- A patch of **white** fur on the back is **shaved**.



- A patch of **white** fur on the back is **shaved**.
- Then, an **ice-pack** was secured over the hairless patch, left in position for weeks and kept cold.
- The hairs that grew back were **black** in colour.

- Himalayan rabbits are homozygous for the c^h allele of the gene for **tyrosinase**. Tyrosinase is one of the enzymes necessary to make **melanin (black pigment)**.

Enzyme coded by one gene's multiple alleles: e.g. C, C^{chd} > C^h alleles

Other alleles

Not sensitive to heat

Himalayan

Sensitive to heat

- Himalayan rabbits are homozygous for the c^h allele of the gene for **tyrosinase**. Tyrosinase is one of the enzymes necessary to make **melanin (black pigment)**.
- The c^h allele specifies a **heat-sensitive** form of the enzyme. This enzyme is active only when the air temperature around the body is below **33°C**.

Too hot → enzyme not working

Why?

Recall: Effect of temp on enzyme reaction

Which part of your body will you feel cold the fastest?

Extremities: feet, hands, ears, etc

Extremities: at slightly lower temp than body core

- When cells that give rise to this rabbit's hair grow under **warmer** conditions, they cannot make melanin, so the hair appears **white**. This happens in body regions that are massive enough to conserve a fair amount of heat.

Inactive enzyme

- In parts of the body that are **cool** enough, ie, the extremities like ears and feet, tyrosinase is active and melanin is produced. Thus, the hairs that grew are **black**.

Gist of each case study

Write on Pg 43

All Himalayan rabbits are the same at genetic level

All same genotype c^h c^h

Different temperatures (body core vs extremities)

Phenotype differs (white vs black areas)

2) Vestigial wi… …sophila

Gene for wing length

- In *Drosophila*, the allele for vestigial wing i… recessive to that for long wing.

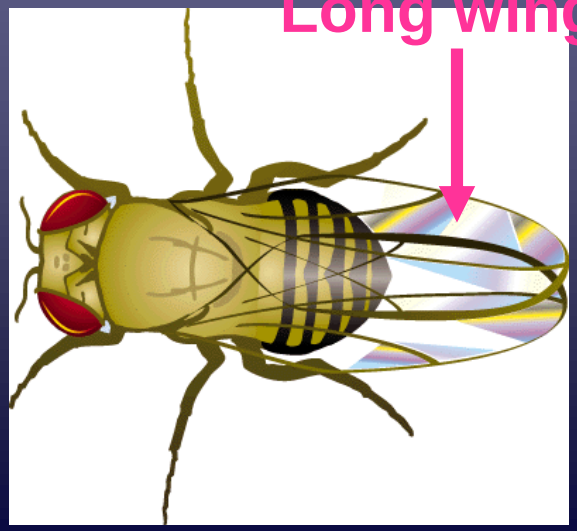
Focus

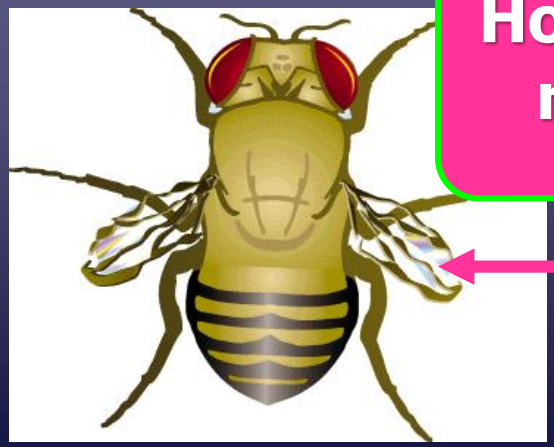
dominant

recessive

(Dominant) Allele for long wing

(Recessive) Allele for vestigial wing





Homozygous recessive

Vestigial wings

- However, the expression of vestigial wing is affected by the temperature at which the insect develops.
- The allele for **vestigial wing** is expressed only at **low** temperatures.

- Drosophila that are homozygous recessive for vestigial wing will develop **vestigial** wings at 21°C, **intermediate** wings at 26°C and **long** wings at 31°C.

Gist of each case study

Write on Pg 44

All vestigial flies are the same at genetic level

All same genotype vgvg (homozygous recessive)

Different temperatures during development

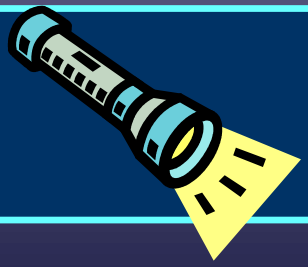
Phenotype differs (length of wings differ)

Effects of Environment on Phenotype

Temperature 

Diet 

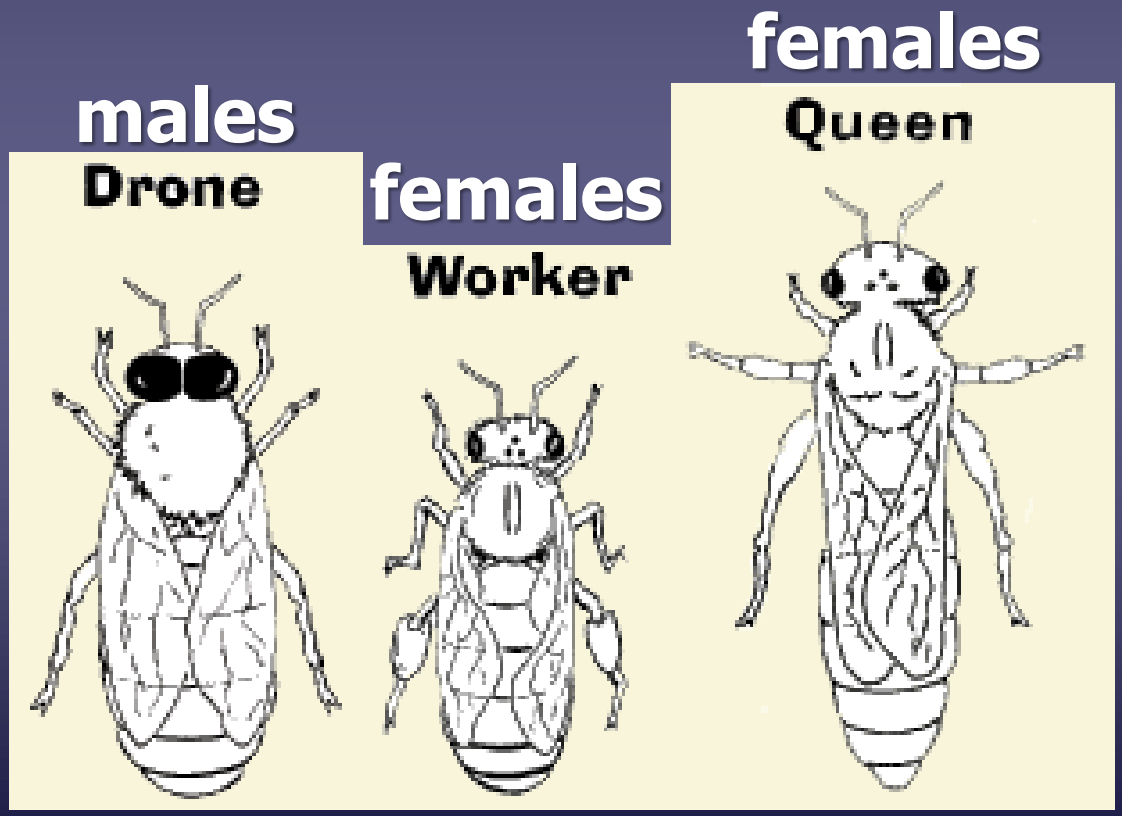
Pg 44

Light 

1) Honeybees

1) Honeybees

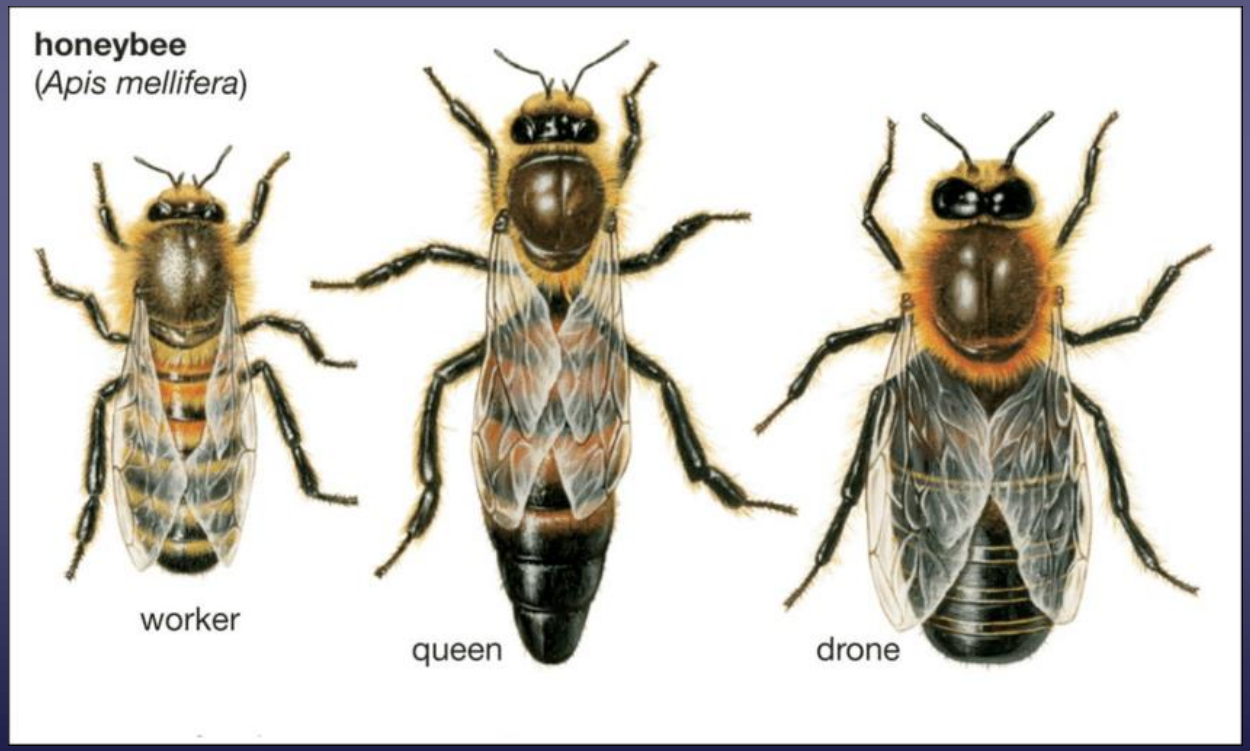
- A bee colony consists of 3 types of individuals: drones, queen and workers.



Pg 44

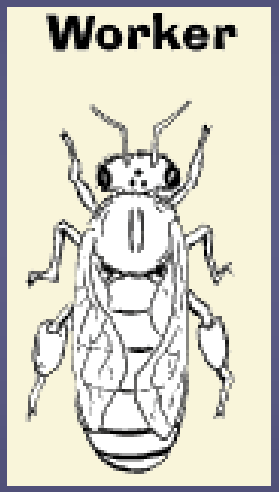
- Drones are males – developed from **unfertilized haploid eggs**.
- Queen and workers are females – developed from **fertilized diploid eggs**.

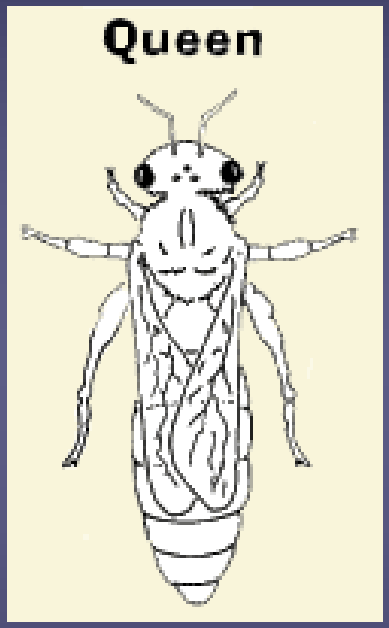
focus



Diploid

- Although queen and workers have the **same amount** of genetic material, they are **phenotypically different**.





- The workers are sterile, smaller in size and have larger mouthparts and modified legs as compared to the queen.

FYI: Male drones: solely for fertilisation

- The phenotypic differences between queen and the workers are due to the **diet** of the larvae.
- After hatching, all the larvae are fed with **royal jelly**.

- The phenotypic differences between queen and the workers are due to the **diet** of the larvae.
- After hatching, all the larvae are fed with **royal jelly**.
- On the third day, larvae destined to be **workers** are switched to a diet consisting of **honey and pollen**.
- Larvae destined to be **queen** **continue** with **royal jelly.** The high protein content of royal jelly stimulates the formation and maturation of the **female reproductive system**.

Gist of each case study

Write on Pg 44

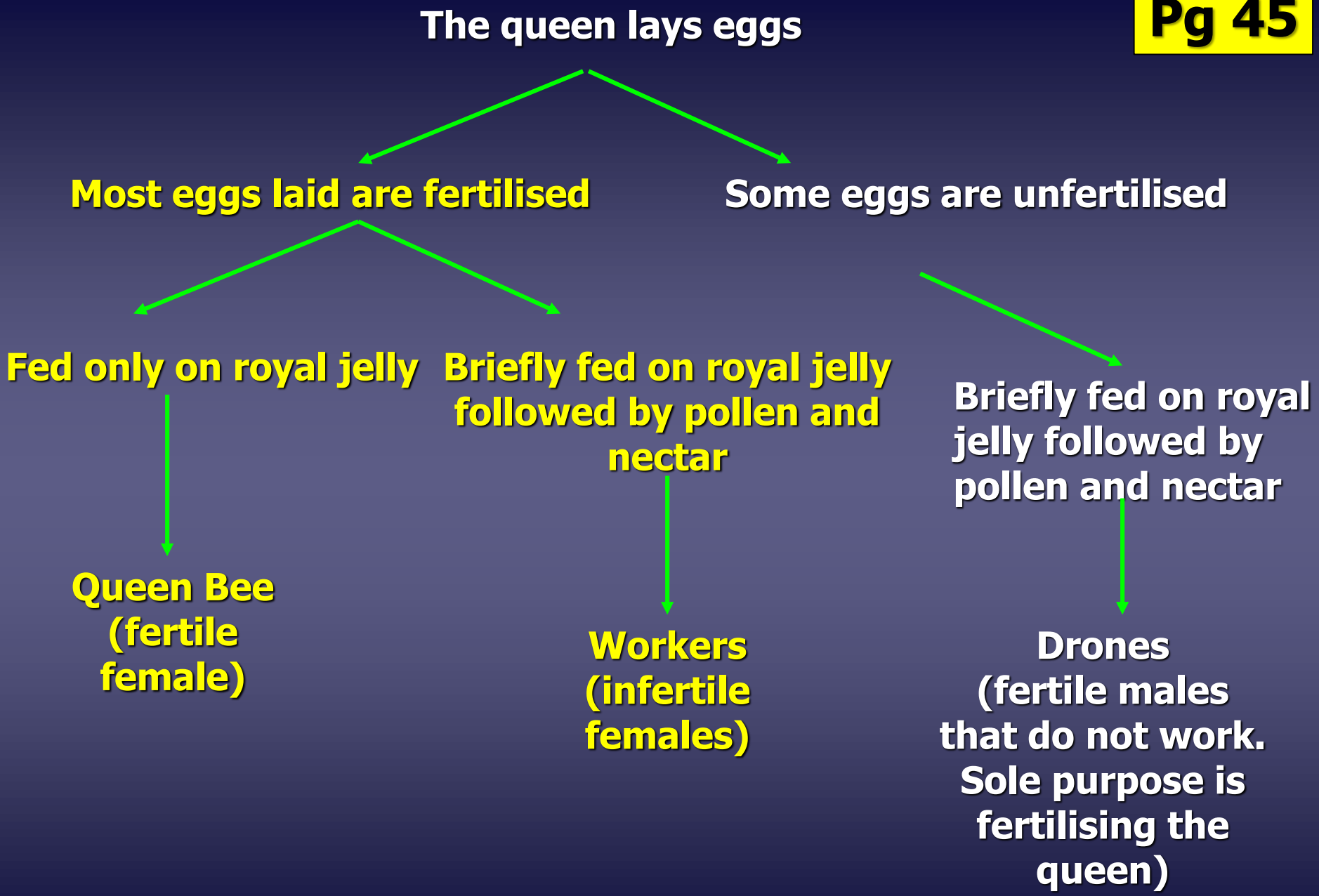
All female honey bees are the same at genetic level

↓

All diploid (2 sets of chromosomes)

Different dietary lifestyle (honey+pollen vs royal jelly)

Phenotype differs (become workers vs queen bee)


The queen lays eggs
Most eggs laid are fertilised
Some eggs are unfertilised
Fed only on royal jelly
Briefly fed on royal jelly followed by pollen and nectar
Briefly fed on royal jelly followed by pollen and nectar
Queen Bee (fertile female)
Workers (infertile females)
Drones (fertile males that do not work. Sole purpose is fertilising the queen)

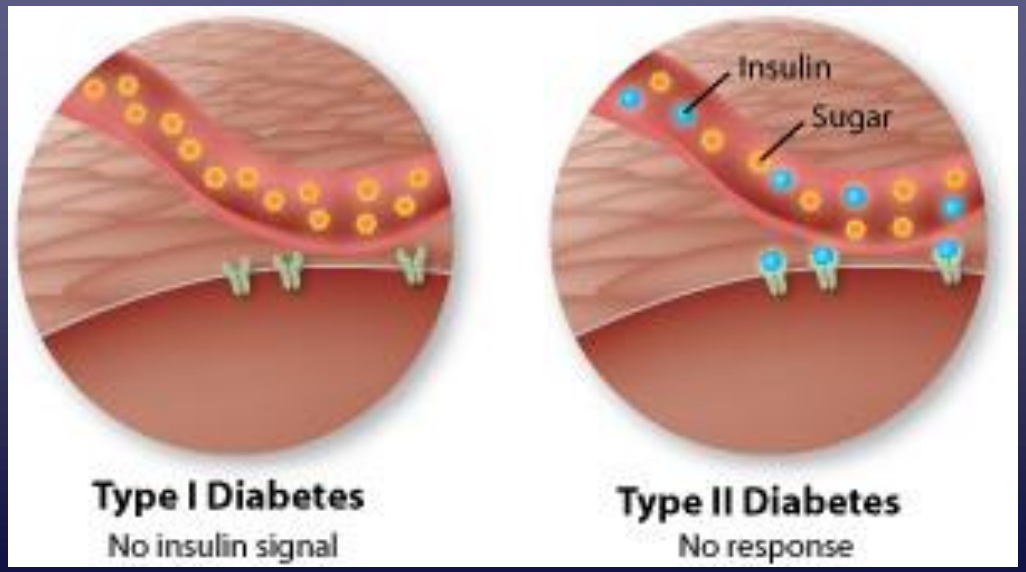
https://www.youtube.com/watch?v=m_SlH3Uwslc

Effects of Diet on Phenotype

2) Late-onset diabetes (Type II diabetes)

- Develops in diabetic individuals who **overeat** but not in genetically diabetic individuals whose diet is **low in sugars and lipids**.

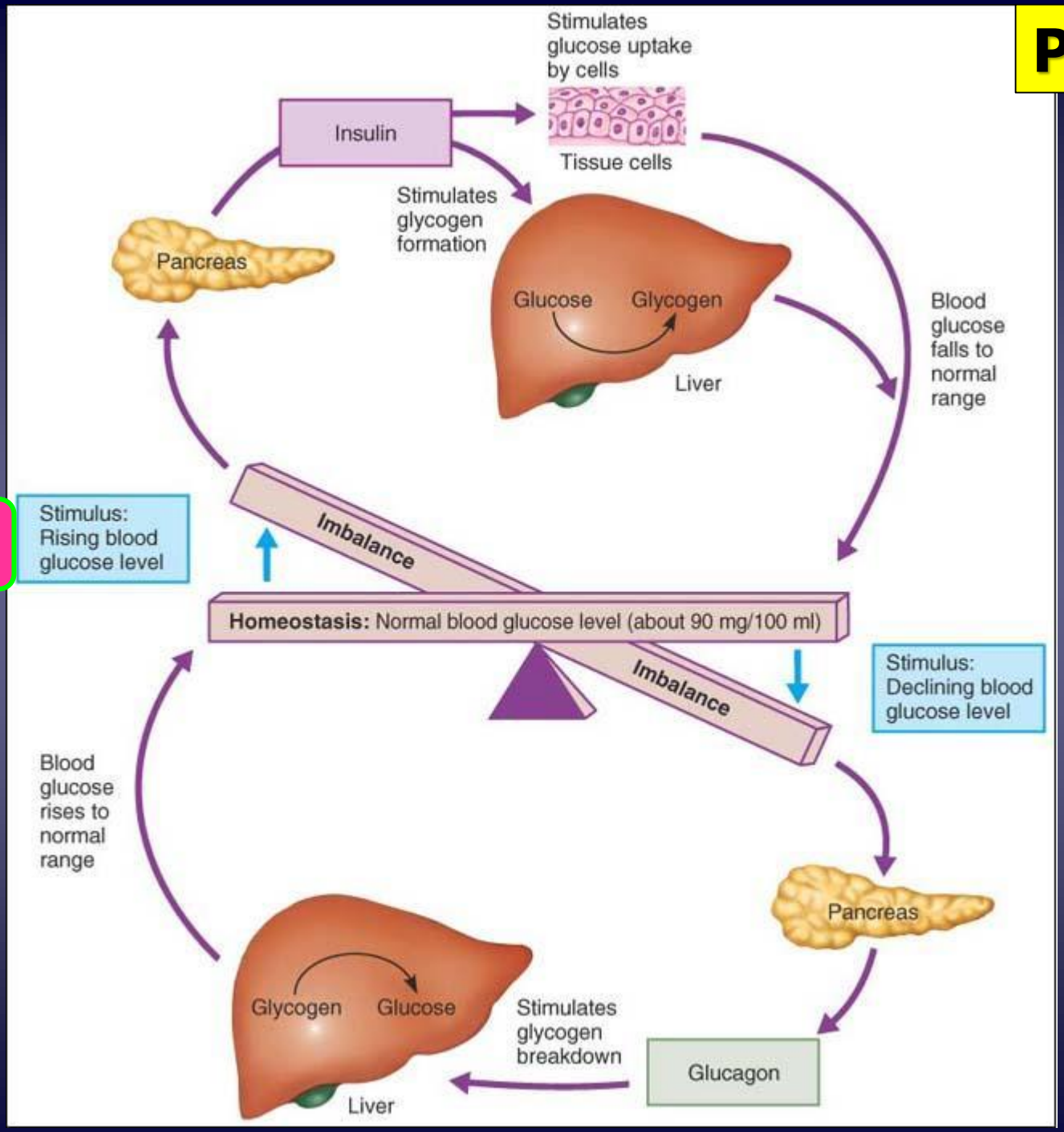
Type 1: genetic; no insulin production



Type 2: diet induced; insulin production but no response to it

Pg 45

Eat ==>

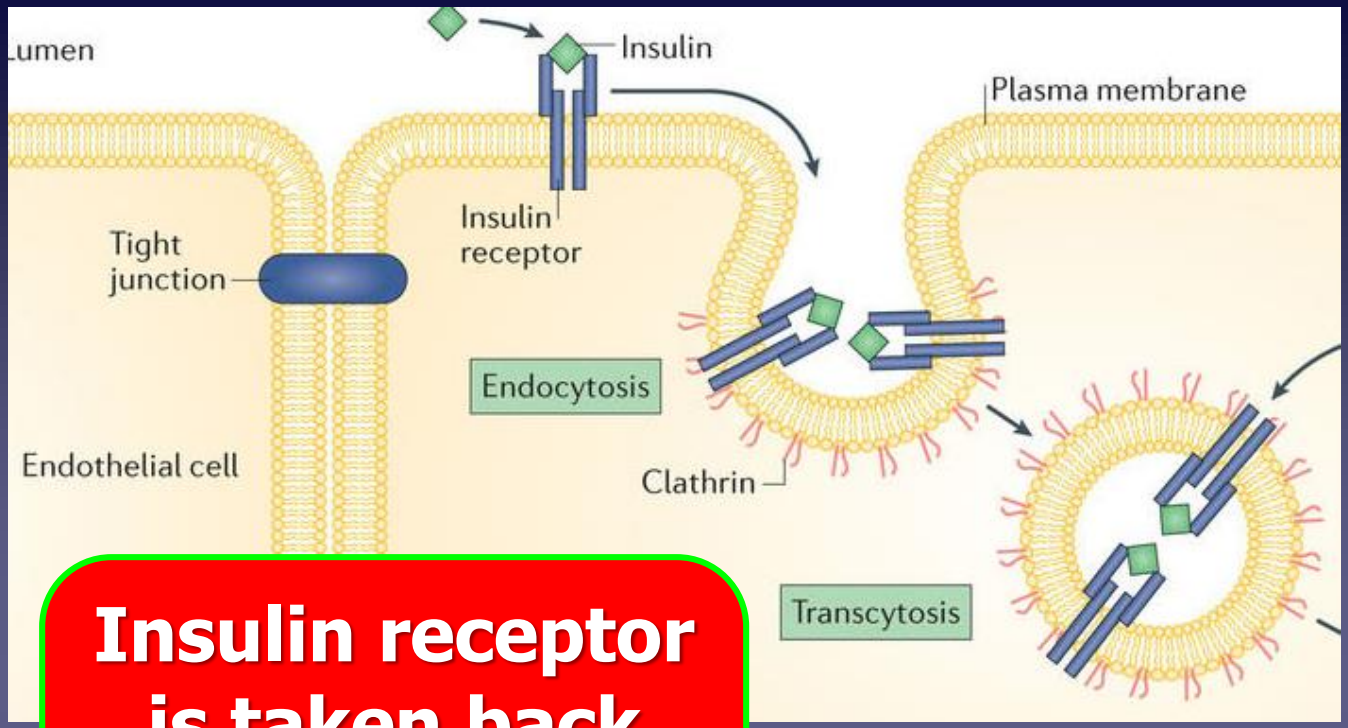

Stimulates glucose uptake by cells
Insulin
Tissue cells
Stimulates glycogen formation
Pancreas
Glucose
Glycogen
Liver
Blood glucose falls to normal range
Stimulus: Rising blood glucose level
Imbalance
Homeostasis: Normal blood glucose level (about 90 mg/100 ml)
Imbalance
Stimulus: Declining blood glucose level
Blood glucose rises to normal range
Pancreas
Glycogen
Glucose
Liver
Stimulates glycogen breakdown
Glucagon

- **Every person without type I diabetes has the same set of genes which results in insulin production & release**
- The hormone **insulin** is secreted when blood glucose level increases.

- The hormone **insulin** is secreted when blood glucose level increases.
- Overeating of sugary foods for a long period of time
- ➔ **repeated stimulation** of the pancreas,
- ➔secreting **high levels** of insulin.
- However, repeated exposure of target cells to large amounts of insulin **desensitises** the cells' responsiveness to insulin.

Discuss with partner! (30s)

What are some suggested mechanisms to desensentise a cell to insulin???



Insulin receptor is taken back into cell by endocytosis???

more widely accepted

Insulin receptor mutated such that it is no longer complementary in shape to insulin???

- Overeating of sugary foods for a long period of time
- → **repeated stimulation** of the pancreas,
- →secreting **high levels** of insulin.
- However, repeated exposure of target cells to large amounts of insulin **desensitises** the cells' responsiveness to insulin.
- This may result in the target cells failing to regulate the levels of glucose in the usual way, resulting in **diabetes**.

Gist of each case study

Write on Pg 45

All non-type I people are the same at genetic level

e.g. Same type of genes which result in insulin production & release

Different dietary lifestyle

Phenotype differs
(some are healthy, some suffer from Type II diabetes)

POLL

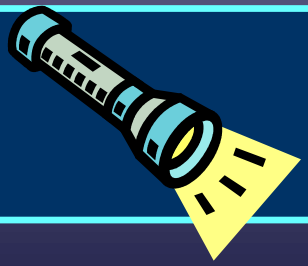
Which case study will you choose to write in a test?

Look at the Learning Objectives

Effects of Environment
on Phenotype

Temperature 

Diet 

Light 

Pg 46

Pg 46

Freckling

Effects of Environment

Effects of Light on Phenotype

Pg 46

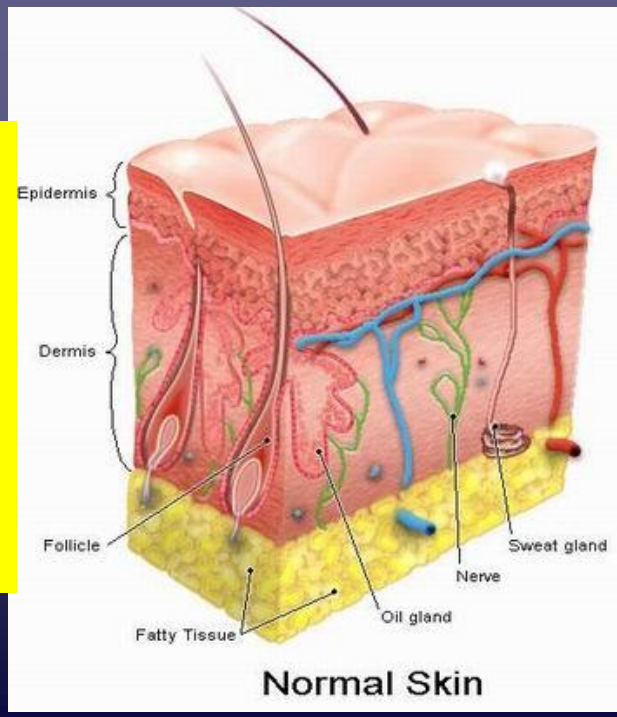
1) Freckling in h

We all have same genes

- Several genes are responsible for freckling but the extent of freckling is determined by **exposure to light**.

Freckles: concentrated melanin pigment

Formation of freckles is triggered by sunlight.
➔ UV-B radiation activates melanocytes to increase melanin production, which can cause freckles to become darker



Gist of each case study

Write on Pg 46

All people are the same at genetic level

e.g. Same type of genes that can make melanin

***Integrate these to your writeup**

Different duration of sunlight/UV exposure

Phenotype differs (freckles vs no freckles)

2) Flowering in photoperiodic plants

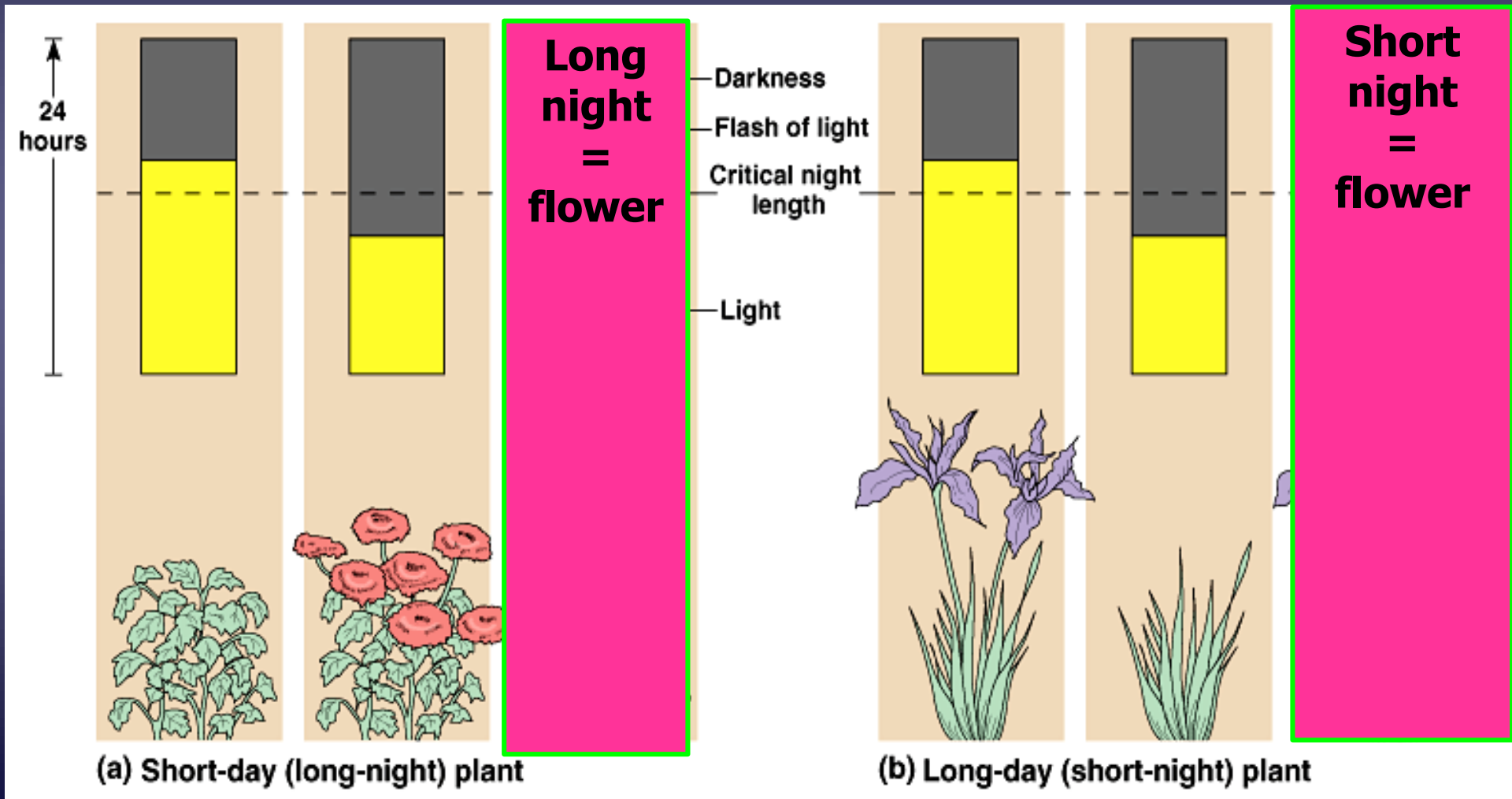
- light
- time

Photoperiodic plants

Pg 46

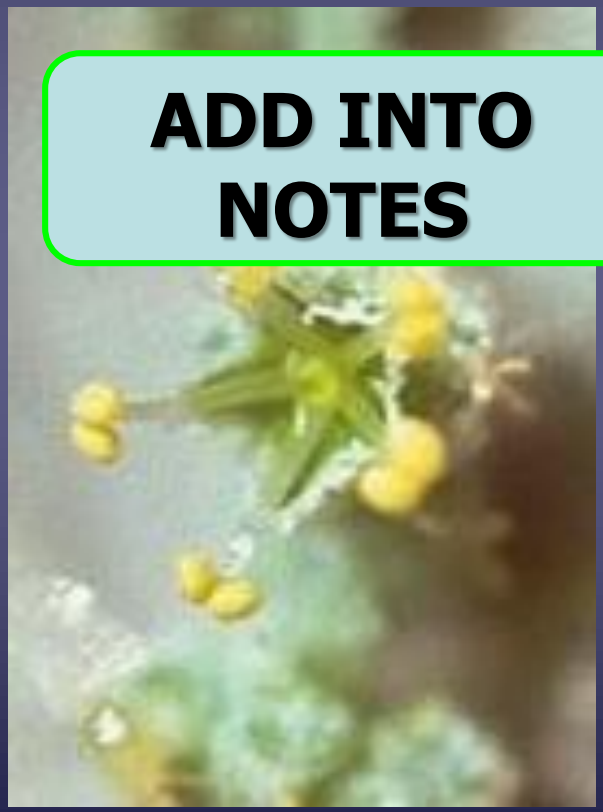
Short-day (long night plant)

long-day (short night plant)



2) Flowering in photoperiodic plants

light **time** **Same genes**



ADD INTO NOTES

- Flowering in photoperiodic **short day/long night** plants depends on the **duration of exposure to darkness**.
  - 12h dark + 12h light → flowers
  - 6h dark + 18h light → only leaves

Gist of each case study

Write on Pg 46

All short day plants are the same at genetic level

e.g. Same type of genes that can cause flowering

***Integrate these to your writeup**

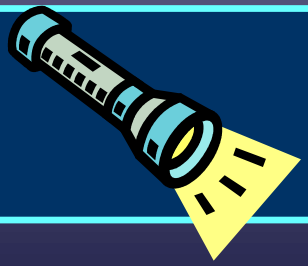
Different duration of darkness

Phenotype differs
(some can flower, some cannot flower)

Effects of Environment on Phenotype

Diet 

Temperature 

Light 

Rem the examples