

HUMAN BIOLOGICAL SCIENCE

Scientific Method



For each of the following hypotheses state the independent and dependent variables and list the other variables that must be controlled in setting up an experiment to test each hypothesis.

1. "That the drug caffeine in coffee causes an increase in heart rate"

Independent variable _____

Dependent variable _____

Other variables that would have to be controlled:	How would you control these in an experiment:

2. "That an increase in the volume of water consumed will cause an increase in the volume of urine produced"

Independent variable _____

Dependent variable _____

Other variables that would have to be controlled:	How would you control these in an experiment:

3. "That regular exercise will increase a person's lung capacity"

Independent variable _____

Dependent variable _____

Other variables that would have to be controlled:	How would you control these in an experiment:

4. "That exercise will increase the skin temperature of a person"

Independent variable _____

Dependent variable _____

Other variables that would have to be controlled:	How would you control these in an experiment:

12. [17 marks]

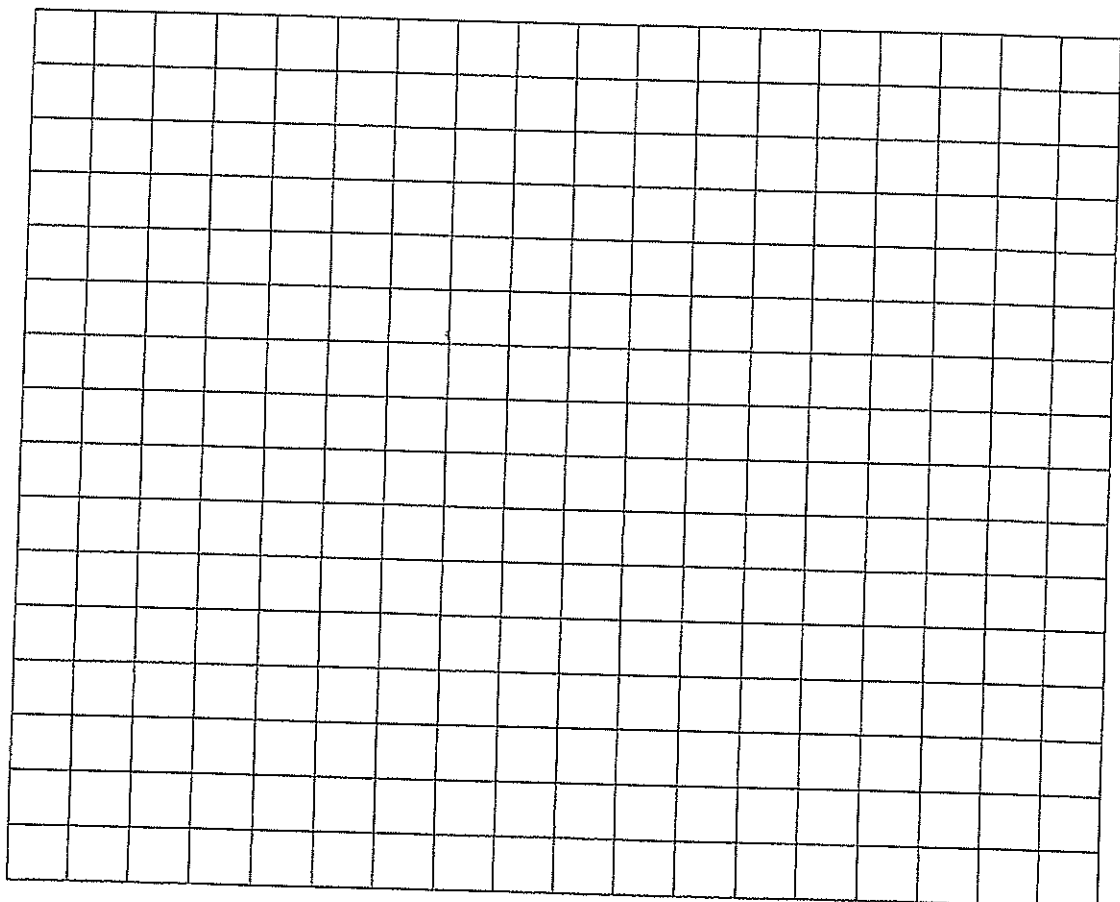
(2009:46)

An investigation was carried out into the effects of exercise on the heart rate and breathing rate of a student. His heart rate, breathing rate and blood pH were first measured at rest. Data were collected after he had cycled for 2 minutes at 5 km/hr on an exercise bicycle. After resting for 5 minutes, the procedure was repeated at cycling speeds of 10, 15, 20 and 25 km/hr. The results are shown in the table below.

Cycling speed (km/hr)	Heart rate (beats/min)	Breathing rate (breaths/min)
0	64	12
5	70	13
10	80	14
15	100	17
20	140	20
25	180	27

(a) Graph these results on the grid provided below.

[5]



(b) Describe the relationship between cycling speed and heart rate.

[1]

CONTINUED NEXT PAGE

- (c) Explain the changes in breathing rate as the cycling rate increased. [3]

- (d) During the investigation, the student was given a 5-minute rest between each 2-minute cycling session. Suggest why this was done. [2]

- (e) The student in this investigation had blood samples taken before any cycling activity and at the end of the investigation. The pH was measured **for both samples** and it was found that the pH had dropped from 7.4 to 7.2 during the investigation.

Explain why this change would have occurred. [3]

- (f) The autonomic nervous system controlled the circulatory system of the student during the investigation.

- (i) Which division of the autonomic nervous system operated on the circulatory system during the cycling stage? [1]

- (ii) How would the autonomic nervous system affect the circulatory system during cycling? [2]

13. [12 marks]

(2010:2.23)

A new drug called Lantus, containing insulin glargine, was approved in 2000 for the treatment of patients who were unable to produce sufficient insulin. Drugs containing NPH insulin had been widely used in the past. Many controlled clinical studies were carried out to enable this approval to be made.

The table below shows the average results produced in some of these trials.

Time after injection (hours)	Glucose usage (mg/kg/min)	
	Lantus	NPH insulin
1	0.2	0.4
2	0.5	1.0
4	1.2	3.0
6	1.2	3.4
8	1.0	2.6
10	1.0	1.8
12	1.0	1.2
14	1.0	0.4
16	1.0	0.3
18	1.0	0.2
20	1.0	0.1
22	1.0	0.0
24	1.0	0.0

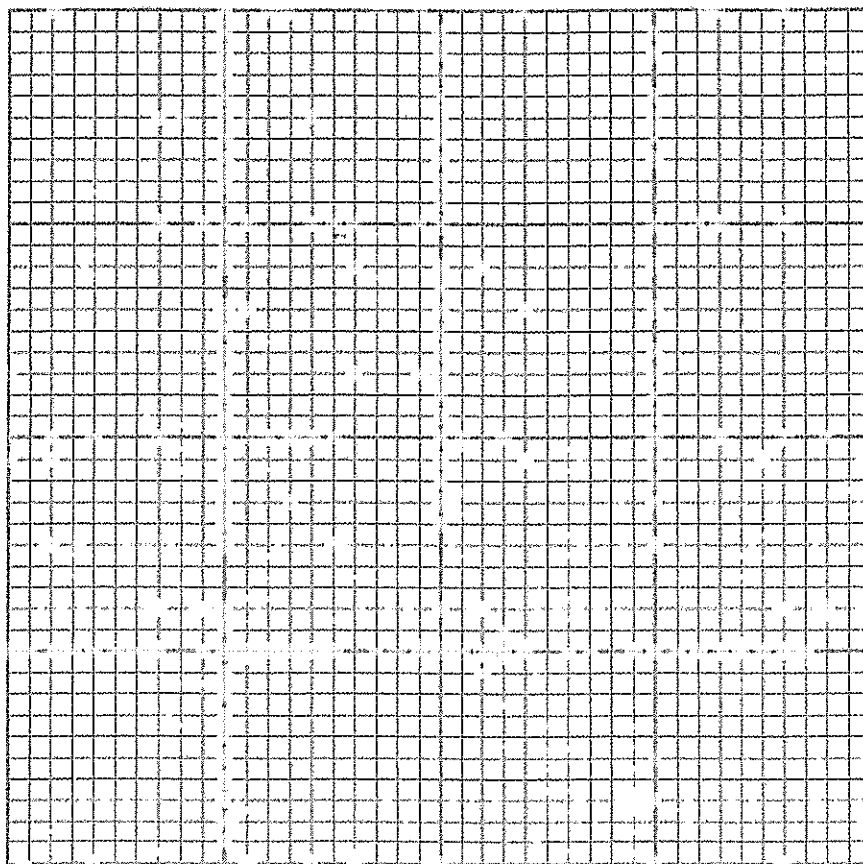
Note: For insulin to be effective, it needs to be able to maintain glucose usage above 0.4 mg/kg/min

- (a) From which disease would these patients be suffering? [1]
- (b) Describe how **two (2)** variables would be controlled in this experiment. [2]

CONTINUED NEXT PAGE

- (c) Graph the results from the table on the grid provided below. [5]

If you wish to have a second attempt at the graph, the grid is repeated on page 47 at the end of this Question/ Answer Booklet. Indicate clearly on this page if you have used the second grid and cancel the working on the grid on this page.



- (d) Using the data from the graph, explain why Lantus would have an advantage over traditional NPH insulin. [2]

- (e) Describe **two (2)** processes involved in 'glucose usage'. [2]

(v) What results would refute the hypothesis?

[1 mark]

(vi) What could you do to be more confident of your results?

[1 mark]

(vii) How would you sample to obtain valid results?

[1 mark]

3. A medical scientist measured the pulse rate of a person while the subject was immersed in a bath of water. The temperature of the water was gradually changed as indicated in the table below. Study the data and answer the questions that follow it.

WATER TEMPERATURE IN BATH (°C)	SUBJECT'S PULSE RATE (bpm)
10	95
15	83
20	78
25	72
30	71
35	78
40	83
45	115

(i) What hypothesis was the scientist testing?

[1 mark]

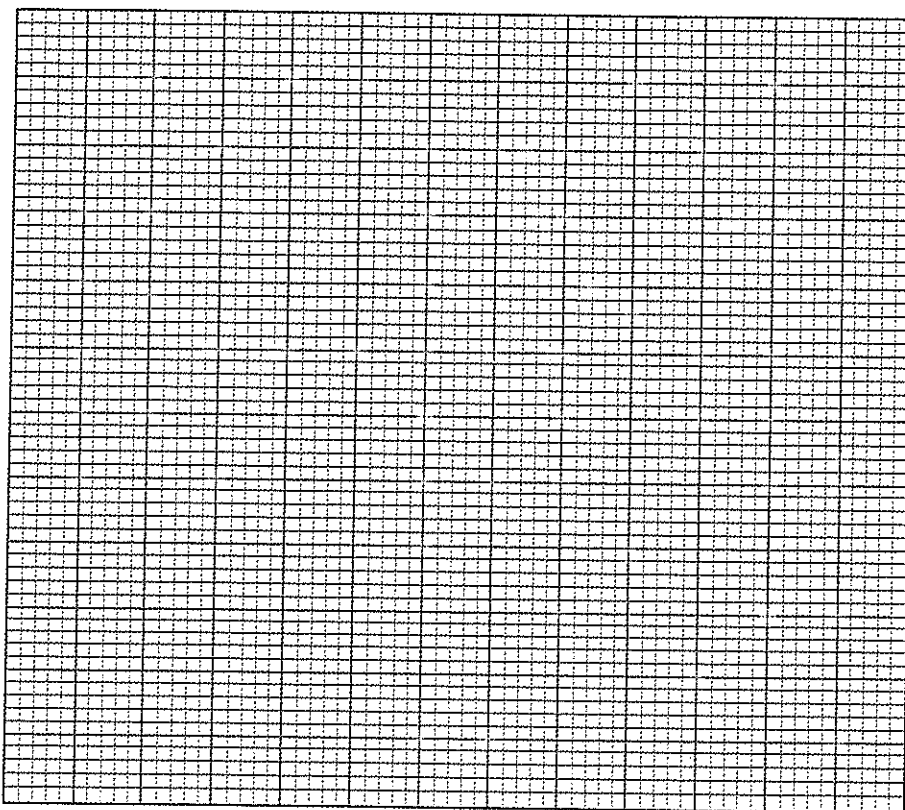
(ii) Name the:

a) independent variable

b) dependent variable

[2 marks]

- (iii) Use the grid below to plot the data in the table.



- (iv) Give one conclusion that can be made from these results. [4 marks]

[1 mark]

- (v) How could this experiment be improved so that the data become reliable?

4. (i) What is a “control” in a scientific experiment?

[1 mark]

[1 mark]

(ii) Why is a control necessary?

[1 mark]

(iii) Why are each of the following important in an experiment?

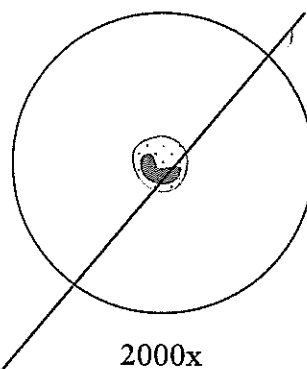
(a) Sample size

[1 mark]

(b) Randomly selected samples

[1 mark]

5. A white blood cell appears in the field of view of a microscope as shown in Figure 1.



(i) If the diameter of field of view is $125\mu\text{m}$, what is the actual size of this cell?

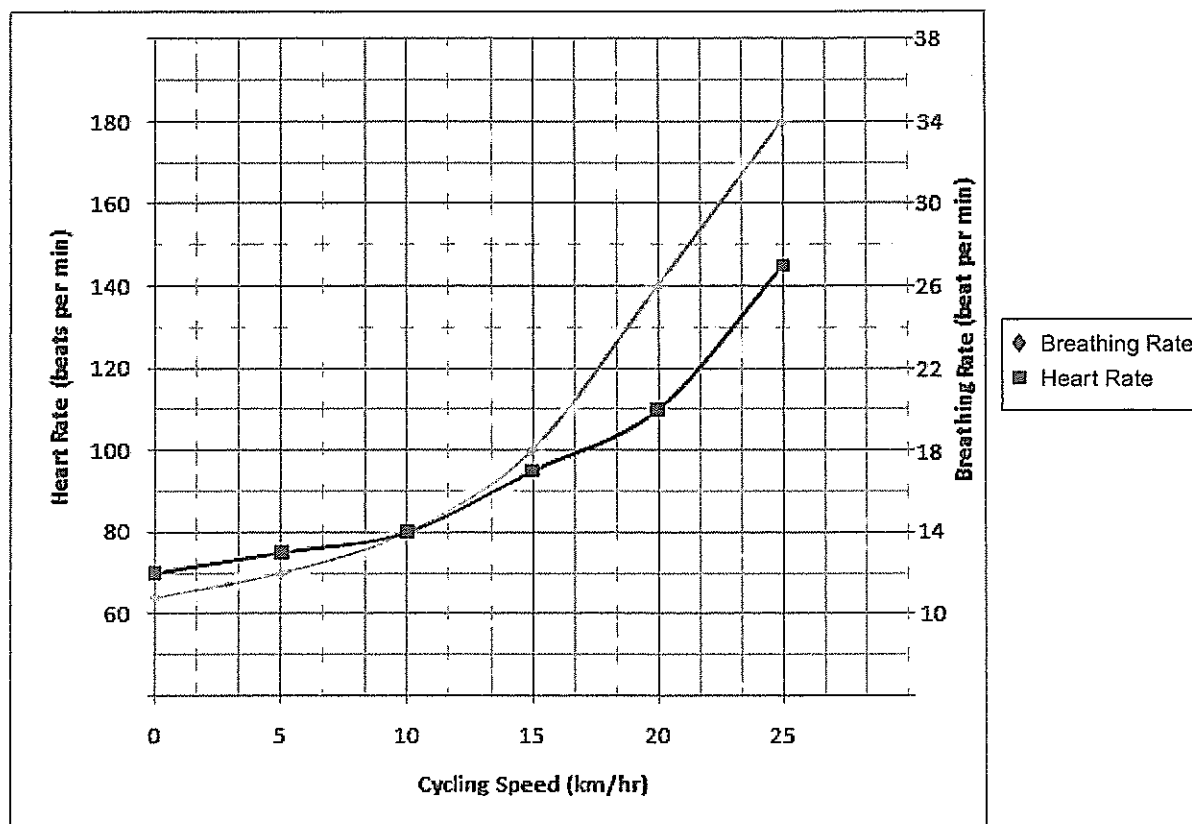
[1 mark]

(ii) What would the diameter of the field of view of this microscope be at a magnification of:

(a) $200\times$ _____ μm (b) $100\times$ _____ μm (c) $40\times$ _____ μm

[3 marks]

Changes in Breathing Rate and Heart Rate with Increased Cycling Speed



- (a) axes – labels and units (1)
 axes – correct numbering (1)
 correct/accurate plotting of data (1)
 line graph (1)
 title (1) must have both variables

If 2 separate graphs on same grid max of 4 marks,
 if use 2 grids max of 3 marks

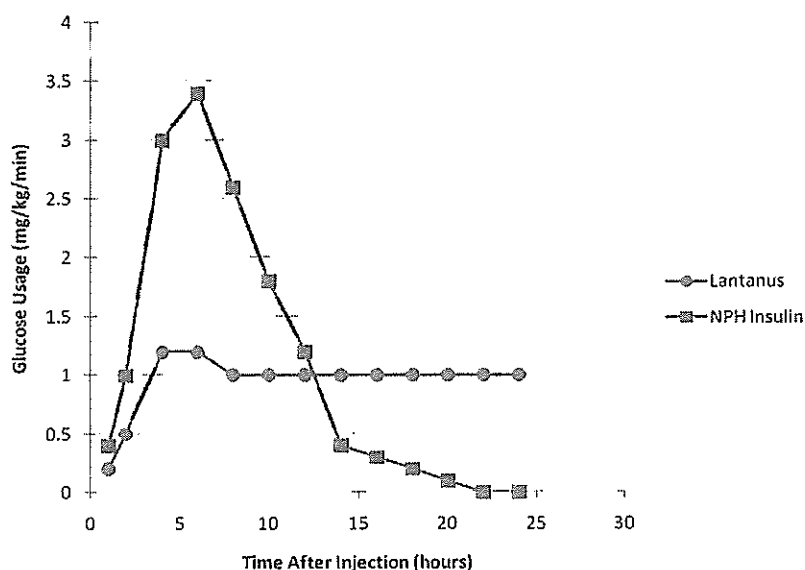
- (b) as cycling speed increases, heart rate increases/direct relationship/positive correlation (1)
- (c) breathing rate increases due to build up of carbon dioxide/ H^+ /low pH (1)
 from increased respiration rate required to supply energy for cycling (1)
 detected by the respiratory centre/chemoreceptors in medulla (1)
 (sympathetic) stimulation of intercostal/diaphragm muscles (1)
 which increases the rate of breathing (1)
- (d) improve the reliability/validity of results (1)
 allow time for the heart rate/breathing rate to return to normal/recovery time before repeating the cycling activity (1)
 acts as control of variable (1)
- (e) pH is changed with the level of carbon dioxide (1)
 lactic acid produced (1)
 increased respiration increases carbon dioxide (1)
 carbon dioxide (dissolved) in blood released H^+ /produces carbonic acid causes a decrease in pH (1)
- (f) (i) sympathetic (1)
 (ii) increases heart rate (1)
 increase stroke volume/cardiac output (1)
 increases vasodilation/blood flow to active muscles (1)
 reduces blood flow to gut/kidneys (1)
 increased venous return (1) increased blood pressure (1)

Any 2 for 2 marks

- 13 (a) Diabetes type 1/insulin dependent diabetes/diabetes mellitus/juvenile diabetes (1)
- (b) Any 2 points for 1 mark each
- The amount of insulin/drug per day the same for each patient (1)
 - The concentration of insulin/drug the same for each patient (1)
 - If using the same group for each type of insulin have a randomised group of adults/children for both NPH and Lantus (1)
 - Carried out over the same period of time (1)
 - Delivery method same for each patient (1)
 - Other factors in people's health/diet taken into account any in this i.e. age, fitness, weight etc (1) mark only
- (max. of 2 marks)

(c)

Changes in Glucose Usage after Time of Injection of Lantus and NPH Insulin



Deduct (1) mark for each point missed

- Two correctly plotted line graphs on the same grid (1)
 - Title must include time and glucose usage (1)
 - Accurately plotted points/straight lines connect points (1)
 - Label x (time) and y (glucose usage) axis must have units (1)
 - Correct scale take up half across grid (1)
 - No extrapolation (no line back to zero) (1)
 - Key for lines/identify lines (1)
- Bar/column graph maximum 2 marks* (max. of 5 marks)

- (d) Any 2 points for 1 mark each
- It remains effective for at least 22 hours/day reverse is fine ((1)6 hrs) (1)
 - Less fluctuations/more stable (1)
 - so would only need to be administered once a day (1)
- (max. of 2 marks)

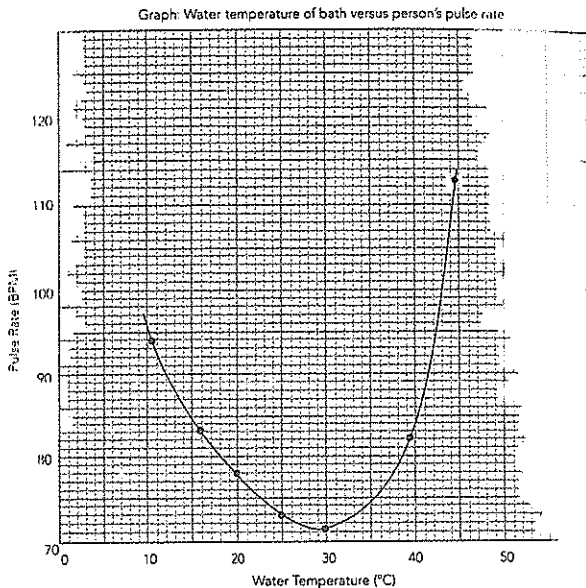
- (e) Any 2 points for 1 mark each
- (Cellular respiration) - breakdown of glucose (1)
 - (Glycogenesis) - conversion of glucose to glycogen in the liver and muscles (1)
 - (Lipogenesis) - conversion of glucose to lipids/fats in adipose tissue (1)
 - Protein synthesis - increased rate of glucose usage (1)
- (max. of 2 marks)

- 14 (a) Either (1)
- CYT006-AngQb/the new drug reduces blood pressure
- Or
- CYT006-AngQb/the new drug causes the greatest reduction in blood pressure in the early morning.
- Any statement that includes directional change between independent and dependent variables

L TESTS

SKILLS 1 (10 marks)

- 3.
- That as the temperature of the bath increases the subject's pulse rate increases.
 - a) The temperature of the bath
b) Pulse rate
 -



Mark allocation:

- Appropriate graph title (with both variables mentioned) [1 mark]
- Axes correctly labeled including units [2 marks]
- Line neatly joining all points [1 mark]

- The hypothesis was not supported by the data. The subject's pulse rate dropped as the bath temperature increased but then began to rise when the temperature exceeded 30°C.
- Repeat the experiment a number of times and randomly select more subjects to test.

- 4.
- A control is a "set up" in which all the variables are made the same as in the experiment except the independent variable.
 - The control enables comparison to be made between the control "set up" and the experimental "set up". In this way we can determine the effect any change to the independent variable may have on the dependent variable.

- Increase the reliability of the experiment; if the sample size is too small it may not be typical of the whole population.
 - Avoid bias. If samples are selected with a

particular feature then the experiment may be invalid.

- 5.
- $125/5 = 25\mu\text{m}$
 - (a) 1250 (b) 2500 (c) 6250
 - (a) 4000 (b) 2667 (c) 1600 (d) 400 (e) 1000
 - $400\mu\text{m}/5 = 80\mu\text{m}$
 - Animals are easier to treat than humans
 - Animals are more expendable – their loss does not create as much anxiety.
 - Animals may benefit from the research as well as humans.
 - Results from animal research do not necessarily apply to humans.
 - Animals may be kept in unnatural or high confinement – treatment may be cruel.
 - Animals may have rights which are not considered in such treatment.
 - Newspaper reports are notoriously inaccurate and often sensational. It would be better to read scientific reports, search the internet for reliable information and to consult with a doctor before reaching your own conclusion regarding such reports.
 - primary data: this is first hand data collected by a student or scientist in doing an experiment or conducting an investigation themselves.
 - scientific error: this is a measure of the accuracy of a measurement. No matter how good a measuring instrument is, there is always a difference between the true measurement and the instrument's measurement. The closer these two are the smaller the scientific error.
 - system: a group of organs which work together to carry out a major function (or functions) within the body, e.g. circulatory system
 - risk assessment: determination of the level of risk associated with a particular exposure or activity in order to plan to reduce the likelihood of damage or injury to people near to or associated with the exposure

Section 3: Extended Answer (20 marks)
(each dot point = 1 mark unless stated).

- Select 100* participants (* large number)
- Randomly from the population
- Divide the group randomly
- 50 in experimental group
- 50 in the control group
- Remove vitamin A from diet of experimental group for several days
- Each group to be treated in every