Science Inquiry in ATAR Human Biology

Skills and Concepts

Outcome 1 – Science Inquiry Skills

Students investigate questions in human biology, evaluate the impacts of advancements in human biology and communicate scientific understandings.

In achieving this outcome, students:

- plan and conduct investigations
- analyse data, draw conclusions, evaluate investigation design and findings
- evaluate the impact of advancements in human biology on individuals and society
- communicate understandings of human biology.

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. This strand is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions, and developing evidence-based arguments.

Science investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modelling and simulations.

In science investigations, the collection and analysis of data to provide evidence play a major role. This can involve collecting or extracting information and reorganising data in the form of tables, graphs, flow charts, diagrams, text, keys, spread sheets and databases. The analysis of data to identify and select evidence, and the communication of findings, involve the selection, construction and use of specific representations, including mathematical relationships, symbols and diagrams.

Through the Human Biology ATAR course, students will continue to develop their science inquiry skills, building on the skills acquired in the Year 7–10 Science curriculum. Each unit provides specific skills to be taught. These specific skills align with the Science Understanding and Science as a Human Endeavour content of the unit.

Part a) Experimental Design (Chapter 1 Pages 3 – 10)

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
- conduct investigations; use microscopy techniques; and perform real or virtual dissection, safely, competently and methodically for the collection of valid and reliable data

Some key concepts to revise:

The following are some of the principles that an investigation involving humans must satisfy if it is to be ethically sound:

- *Voluntary participation* – the subjects should not be pressured into taking part in the investigation.
- *Informed consent* – the subjects should be fully informed about the objectives of the research, the procedures to be followed, any possible risks and the potential benefits of the research; consent should only be sought after all information has been given.
- *No risk of harm* – as mentioned in the section on safety, there should be no risk of physical or psychological harm.
- *Confidentiality* – the identities of participants will not be revealed except to people directly involved in the study.

Just as humans must be treated in an ethical way, so too must animals. The requirements for investigations involving animals are set out in the *Australian Code for the Care and Use of Animals for Scientific Purposes, 8th edition (2013)*. The code sets out detailed requirements, but in general terms any use of animals in research or teaching should be:

- valid
- humane
- justifiable
- considerate.

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The Code defines the 3Rs as follows:

- Replacement: methods that permit a given purpose of an activity or project to be achieved without the use of animals.
- Reduction: methods for obtaining comparable levels of information from the use of fewer animals in scientific procedures or for obtaining more information from the same number of animals. (The Code also outlines that the number of animals used must satisfy good statistical design, and that the use of too few animals may invalidate experimental results and cause wastage of animals [Clause 1.21].)
- Refinement: methods that alleviate or minimise potential pain and distress, and enhance animal wellbeing.

https://www.nhmrc.gov.au/research-policy/ethics/animal-ethics/3rs - for more information access this link

Past Exam Questions:

2015 Question 36

Apnoea of prematurity is a common condition in premature infants (infants born earlier than 38 weeks gestation). Apnoea results in a complete stoppage in breathing for up to 20 seconds or more. Apnoea has various causes but if left untreated can result in low blood pressure and heart rate, brain damage, and sometimes death. Infants with apnoea of prematurity often require help with their breathing, which may include insertion of a breathing tube (intubation) or being supplied with oxygen-rich air in the humidicrib. One of the most common drug treatments for apnoea of prematurity is daily doses of caffeine, which helps to stimulate the breathing reflex and eliminate the symptoms of apnoea.

Presented below are some of the results from an experiment on the effects of caffeine in premature infants. In group A, 960 infants were administered daily doses of oral caffeine. In group B, 932 infants were administered daily doses of an oral placebo. All infants in the experiment were born between 26 and 28 weeks gestational age. All were given daily doses of either caffeine or the placebo for six weeks.

	Mean age of infants (gestational age) in weeks	
	Group A	Group B
Age at first dose	27.8	28.1
Age at last dose	33.8	34.1
Age at last use of breathing tube (intubation) required	29.5	30.4
Age at last use of additional oxygen required	33.7	35.3

(a) Identify **two** variables that were controlled in the experiment. (2 marks)

- Oral administration of drug + placebo
- Dose of drug + placebo.
- All subjects born premature
- All subjects have apnoea of prematurity.

(b) During the experiment, group B received a placebo.

(i) Define 'placebo'. (1 mark)

An inactive substance which is administered in the same way and looks the same as the active drug.

(ii) Why are placebos usually administered in experiments? (1 mark)

- To act as a control to compare results with the experimental group.
- To reduce/eliminate psychological effects

2018 Question 38

An investigation was carried out into the effectiveness of a new asthma bronchodilator, to be used to increase the oxygen concentration in the blood of patients suffering from chronic asthma.

Two groups of patients suffering from chronic asthma were treated: group 1 received the new asthma bronchodilator and group 2 a placebo. The base level of oxygen concentration in the blood of the patients in the two groups was measured daily over a period of two weeks prior to the trial.

All patients in both groups began with a similar blood oxygen concentration of 94%, which was 4% lower than normal blood oxygen concentration. After three weeks of the trial, patients in group 1 had an average oxygen concentration of 98%, while group 2 still had an average blood oxygen concentration of 94%.

(a) Suggest a hypothesis that this experiment was designed to test. (1 mark)

Patients using the new asthma bronchodilator will have an increase in blood oxygen concentration compared to those in the placebo group.

(b) Name the independent and dependent variables. (2 marks)

IV: Asthma bronchodilator.

DV: Blood oxygen concentration.

(c) Why was a placebo used for group 2 participants? (1 mark)

To compare with the experimental group - to act as a control group.

(d) State **three** variables that would need to be controlled to ensure that the experiment was a fair trial. (3 marks)

- All patients have chronic asthma.
- Oxygen concentration measured daily
- Same method of administration - bronchodilator.
- Same amount administered to each group.
- Similar amount/intensity of daily exercise.

2020 Question 9

Eloise wanted to investigate the effect of temperature changes on the basal metabolic rate of rats. According to the *Australian code of practice for care and use of animals for scientific purposes, eighth edition 2013*, she must follow the principles of the 3Rs for the ethical and humane care of the animals. Which of the following is **not** one of the 3Rs?

(a) Replacement – that wherever possible one should use alternative approaches that do not use animals.
(b) Reduction – one should use the smallest number of animals possible to achieve the aims and statistical design requirements.
(c) Refinement – one should modify methodology to minimise harm to the animals.
(d) Repetition – one should repeat the investigative approach to ensure consistent results.

Part b) Representing Data (Chapter 1 Pages 11 – 16)

- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error, and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
- represent data in meaningful and useful ways, including the use of mean, median, range and probability; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error, instrumental accuracy, the nature of the procedure and the sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions

Past Exam Questions:

2013 Question 36

A recent study investigated the effects of MDMA (ecstasy) on human thermoregulation. The research team selected 10 individuals (male and female) aged between 18 and 35 years. Each participant attended two sessions, one week apart. At the first session participants received, in tablet form, either a placebo or 2 mg/kg of MDMA. If at the first session participants received a placebo, at the second session they received MDMA, and vice versa.

At each session, participants assembled in a room at 10 am with the room temperature at 23 °C. After 30 minutes, the room temperature was changed to 30 °C, which took about 2 minutes. Data collection began at 11 am, when the drug or placebo tablet was given with a small amount of water. Recordings of core body temperature were taken every hour for the next 4 hours, with the session concluding at 3 pm.

Data for each of the **five** time periods were averaged and recorded (in order of time starting at 11am) in a notebook as follows:

MDMA: 36.9 °C, 37.1 °C, 37.5 °C, 37.6 °C, 37.6 °C
Placebo: 36.9 °C, 37.0 °C, 37.0 °C, 37.1 °C, 37.1 °C

hours also accepted.

(a) Present the above data in a table. (5 marks)

core body temperature of patients after being given MDMA or placebo. (1)

(1) Time first

Time (mins)	core body temperature (°C)	
	With MDMA	With Placebo
0	36.9	36.9
60	37.1	37.0
120	37.5	37.0
180	37.6	37.1
240	37.6	37.1

Headings (1)

Units (1)

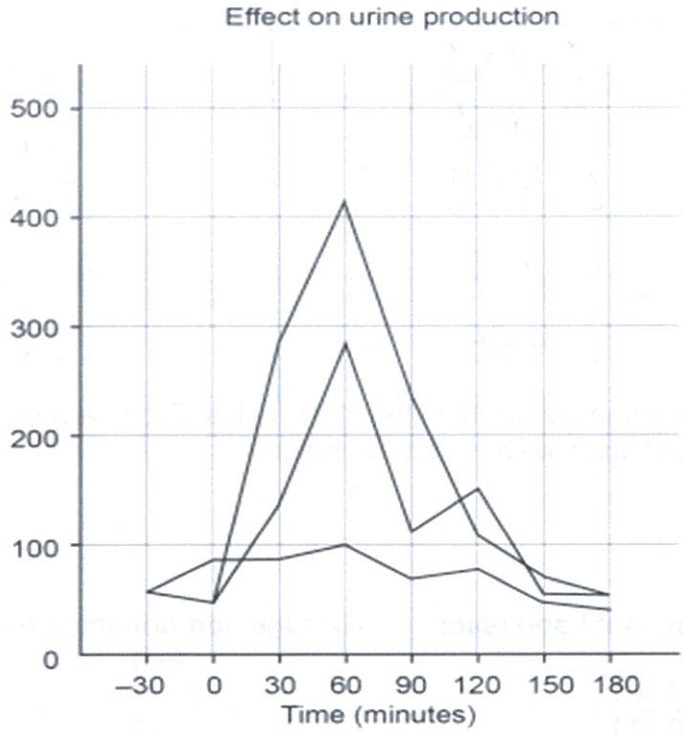
(1) Data

2017 Question 33

Scientists decided to investigate how urine production was affected by drinking different salt solutions. They chose three groups of 10 volunteers. Each group drank 1 litre of different solutions: Group 1 distilled water; Group 2 10% salt solution; and Group 3 30% salt solution. Urine samples were collected from each person that participated in the experiment 30 minutes before they drank the solution and then every 30 minutes afterward, and the volume of urine was then recorded. The graph and table below show the average volume of urine collected every 30 minutes from each group.

Time (minutes)	Average urine production (mL)		
	Group 1 Distilled water	Group 2 10% Salt solution	Group 3 30% Salt solution
–30	56	58	55
0	48	47	51
30	287	138	85
60	415	285	98
90	235	112	67
120	103	82	77
150	68	54	46
180	54	52	40

The graph shown below is a student's attempt to represent the data shown in the table.



(a) Identify **three** errors in the graph. (3 marks)

- Title doesn't mention both variables.
- Plotting errors - data not correct (see -30 min values)
- No key
- No label for Y-axis
- Scale incorrect on X-axis

2019 RSHS Sem II Exam Question 33

A year 12 Human Biology student was interested to find out whether or not reaction times were affected by the use of the dominant or non-dominant hand. To test this the student found a reaction time test on the internet where you had to click the mouse when a coloured dot changed, and the computer would display the reaction time in seconds after every attempt. She did the test five times with each hand.

With the non-dominant hand, she scored 0.483, 0.212, 0.357, 0.29 and 0.455; whereas, with the other hand, she scored 0.470, 0.612, 0.417, 0.320 and 0.280.

(a) Draw a table of results based on the information given above. (3 marks)

Reaction times of student using dominant and non-dominant hand.

Test Number	Time (seconds) with units	
	Dominant hand	Non dominant hand.
1	0.483	0.470
2	0.212	0.612
3	0.357	0.417
4	0.290	0.320
5.	0.455	0.280.

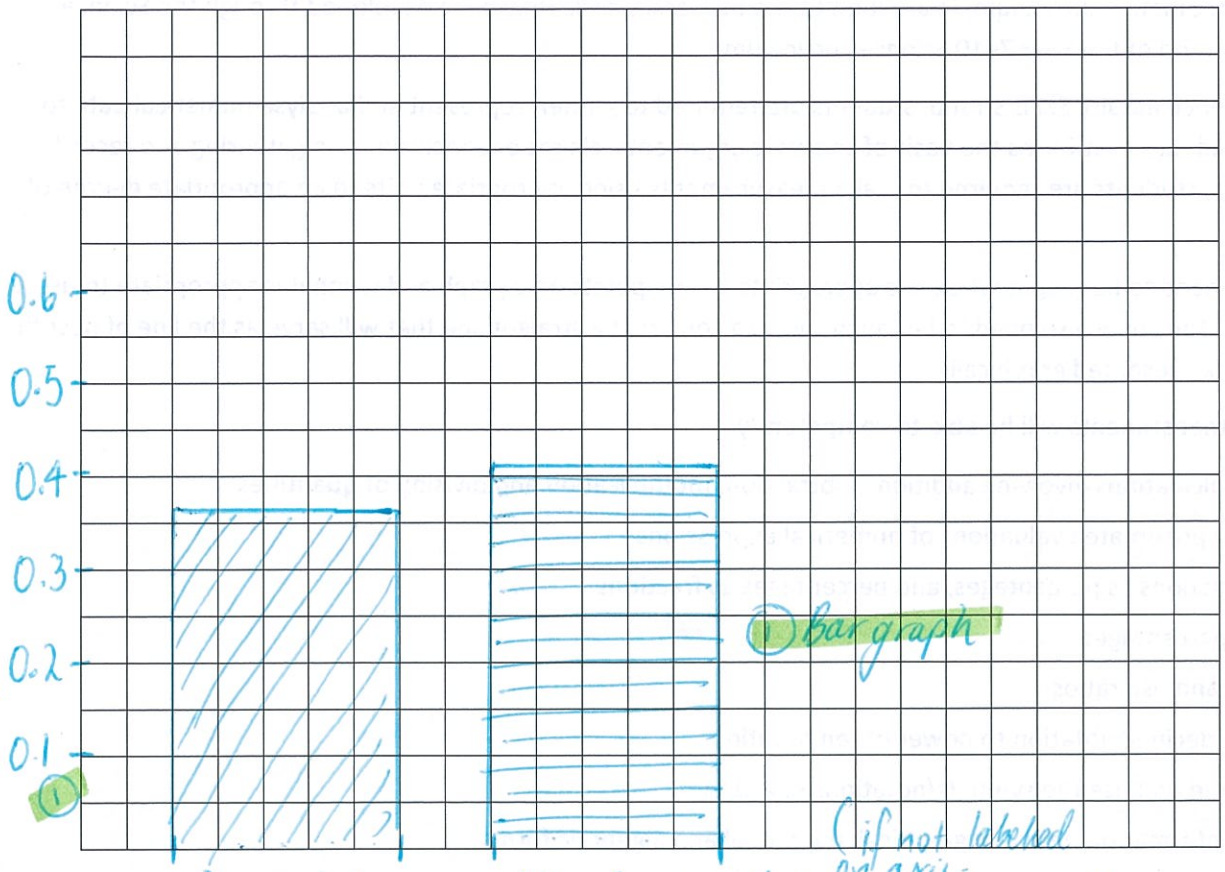
The student decided to conduct the same test on 10 of her class mates. Each participant had to complete the same test 5 times with each hand and then record the average.

The results are shown below.

Participant number	Average dominant hand (sec)	Average non-dominant hand (sec)
1	0.361	0.384
2	0.411	0.521
3	0.172	0.169
4	0.223	0.256
5	0.311	0.320
6	1.100	1.421
7	0.228	0.308
8	0.201	0.212
9	0.199	0.212
10	0.318	0.310
Average	?	?
	0.352	0.411

(b) Use these results to create a graph showing the combined average time for the dominant hand and combined average time for the non-dominant hand. Graph this on the grid paper below. (6 marks)

Average reaction time of 10 participants when using their dominant and non-dominant hand (1) (1).



Part c) Mathematical Skills (Chapter 1 Pages 12 – 14)

Mathematical skills expected of students studying the Human Biology ATAR course

The Human Biology ATAR course requires students to use the mathematical skills they have developed through the Year 7–10 Mathematics curriculum, in addition to the numeracy skills they have developed through the Science Inquiry Skills strand of the Year 7–10 Science curriculum.

Within the Science Inquiry Skills strand, students are required to gather, represent and analyse numerical data to identify the evidence that forms the basis of scientific arguments, claims or conclusions. In gathering and recording numerical data, students are required to make measurements using appropriate units to an appropriate degree of accuracy.

Students may need to be taught when it is appropriate to join points on a graph and when it is appropriate to use a line of best fit. They may also need to be taught how to construct a straight line that will serve as the line of best fit for a set of data presented graphically.

It is assumed that students will be able to competently:

- perform calculations involving addition, subtraction, multiplication and division of quantities
- perform approximate evaluations of numerical expressions
- express fractions as percentages, and percentages as fractions
- calculate percentages
- recognise and use ratios
- transform decimal notation to power of ten notation
- comprehend and use the symbols/notations $<$, $>$, Δ, $\approx$
- translate information between graphical, numerical and algebraic forms
- distinguish between discrete and continuous data and then select appropriate forms, variables and scales for constructing graphs
- construct and interpret frequency tables and diagrams, pie charts and histograms
- describe and compare data sets using mean, median and inter-quartile range
- interpret the slope of a linear graph.

Some key concepts to revise:

Percentage change

Calculating a percentage increase or decrease is often a good way to understand changes in a variable over time. For example, if a person weighing 100 kg lost 10 kg after dieting for six months, we could say that the person had lost 10% of their body weight as a result of the diet. If another person weighing 120 kg lost 13 kg after six months on the same diet, the percentage decrease would be 10.8%. Percentage change is helpful in making such comparisons.

To calculate percentage change:

1. *subtract* the old value (120 kg) from the new value (107 kg)
2. *divide* by the old value (120 kg)
3. *multiply* the result by 100 and add a per cent sign (%) to it.

This can be written as a formula:

$$\text{Percentage change} = \frac{\text{New value} - \text{Old value}}{\text{Old value}} \times 100$$

If the percentage change is positive, it indicates an increase; if the change is negative, it indicates a decrease.

Median

The median is the middle of a set of numbers. It divides the lower set of numbers from the upper set. For example, the heights of the members of a cricket team were measured and (in centimetres) they were: 164, 176, 177, 177, 178, 181, 182, 182, 183, 185, 191.

The median height of the team was 181 cm; that is, 181 is the middle value – there are five team members with heights lower than 181 cm and five with heights higher. If there is an even number of measurements, then the median is taken as the mean of the two values in the middle of the set of numbers.

Using the median of a set of numbers reduces the influence of outliers. Outliers due to measurement error could have a significant effect on the mean of a set of numbers, but would have much less effect on the median.

Range

A measure of the centre of a group of numbers can be misleading. The mean, or the median, gives us no idea about whether all the values are clustered around the centre or whether there is a very wide spread from highest to lowest value. Any description of a set of numbers should therefore include both a measure of centre and a measure of spread.

The simplest way to indicate the spread is to quote the range – that is, the highest and lowest measurements in the group. For example, we could say that the heights of students in a Year 12 class ranged from 151 to 183 cm, with a mean of 171 cm.

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Past Exam Questions:

2020 RSHS Sem I Exam Question 31

The average systolic blood pressure results for 9 of the Group 1 participants for the two-week medication trial were.

Participant	1	2	3	4	5	6	7	8	9
Average Systolic Blood pressure (mmHg)	140 (8)	135 (7)	134 (5)	150 (9)	130 (4)	127 (2)	125 (1)	135 (6)	128 (3)

Middle Set - Arrange in order.

(a) State the **median** blood pressure (arranged by systolic pressure). (1 mark)

Middle number is 5 (1-4)(6-9) => 134mmHg

(b) State the **mean** systolic blood pressure for this group of participants. (1 mark)

Add all values and divide by 9 = 133.8 → rounded to nearest whole.
= 134mmHg

Nelson Chapter 1 Review Question 18

SYSTOLIC BLOOD PRESSURE OF YEAR 12 STUDENTS (mmHg)					
109	123	141	115	131	126
144	138	106	115	49	109
125	132	128	114	116	120
195	143	132	116	13	

a Are there any obvious outliers in the data in the table? If so, which are the outliers and why should they be regarded as outliers?

b Calculate the mean systolic blood pressure for the class, excluding any outliers.

c What is the range of blood pressures in the class?

d What percentage of students had a blood pressure of 130 mmHg or higher?

e The average systolic blood pressure for adults is 120 mmHg. What proportion of students have blood pressures above this average?

a) 13, 49 and 195
- Significantly lower and higher than other values.

b) $\frac{\text{(Add values)}}{20}$

$= \frac{2,483}{20}$

$= 124.15$ mmHg.

(or 124 mmHg - rounded)

c) With outliers = 13 - 195

Excluding outliers = 106 - 144

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d) With outlier = 8 out of 23.

$= \left(\frac{8}{23}\right) \times 100. = 34.8\%$

Without outlier = 7 out of 22

$= \left(\frac{7}{22}\right) \times 100 = 31.8\%$

e) With outliers. 12 : 10.

Without Outliers 11 : 8.

Nelson Chapter 1 Apply your Knowledge Question 9

During an investigation about the effect of different types of exercise, the following pulse rates, in beats per minute were recorded prior to exercise.

54	65	62	58	60	66	84	57	61	65	59	63

a) Calculate the mean for this data

$\frac{\text{Add values}}{12} = \frac{754}{12} = 62.8 \text{ bpm. (including outlier)}$

b) Identify any outliers in the data

84 bpm.

c) State the median pulse rate

12 values → 54, 57, 58, 59, 60, 61, 62, 63, 65, 65, 66, 84

$= 61.5$ bpm

d) State the age range for the data

54 - 84

e) During exercise, the mean pulse rate was 96 beats per minute. Calculate the percentage increase in pulse rate due to exercise

mean before = 62.8 bpm

mean after = 96 bpm.

$$\text{Percentage change} = \left(\frac{\text{New value} - \text{Old value}}{\text{Old value}}\right) \times 100.$$

$$= \left(\frac{96 - 62.8}{62.8}\right) \times 100.$$

$= 52.9\%$ increase.