21. [8 marks] *(2004:29)*

A space probe recently returned to Earth from a distant planet, with samples containing bacteria *X*.

Biologists are interested in comparing the activity of an enzyme found in bacteria *X* with that found in bacteria *E* from Earth. Both bacteria contain an enzyme that produces a gas as a product of its activity on the same substrate.

Bactera X - other planet
E - Earth

	Environmental conditions where bacteria were collected	
	Temperature (°C)	*pH*
Bacteria *X*	50–80	5.5–7.5
Bacteria *E*	37–55	6.5–8.5

State a hypothesis to be tested, and plan an investigation you could carry out to compare the activity of the enzymes found in these TWO bacteria under ONE of these conditions.

HYPOTH
TEMP : Bacteria X enzyme has greatest activity at higher temps than Bact E enzyme. (ie enzyme X has a higher optimum temp. than E)
OR.
PH : .... greatest activity within pH range 5·5 – 7·5 etc.

METHOD (temp) : Independent variable : temp eg. 30, 40, 50, 60, 70, 80°C (change x5) water baths + thermom. to measure temp.

Keep constant (controlled variables) : • pH (7 as with range of both) • substrate – type + volume (10 mL). • same test tubes • volume of each enzyme (1 mL)

Dependent variable : volume of gas produced in one minute after enzyme added at each temp (use stopwatch + count bubbles).

Control : test tube with substrate + add 1 mL distilled water at each temp.

19. [7 marks]

A plant breeder replicated one of Mendel's pea plant breeding experiments. The results of the cross between green (G) pods and yellow (g) pods are shown in the table.

Generation	Pod colour	
	Green (G)	Yellow (g)
F1	632	0
F2	1560	482

P GG × gg
F_1 all Gg
F_2 1 GG : 2 Gg : 1 gg

3 green : 1 yellow = MONOHYBRID RATIO.

(a) List all possible genotypes of the *F*2 generation. **[1]**

GG, Gg + gg.

(b) Using your understanding of current genetic thinking, interpret the results of the *F*2 cross depicted above. **[3]**

NB. mistake in wording → should be results of F_1 cross or F_2 results (as no F_3).

F_1 two parents Gg × Gg crossed.

	G	g
G	GG	Gg
g	Gg	gg

← ie alleles from each parent separated at gamete formation (during MEIOSIS) + randomly fused at fertilisation
ie 3 green : 1 yellow predicted
≈ 1500 : 500 (close to F_2 value)

(c) Describe the features of TWO experimental techniques used by Mendel that led to his success. **[3]**

"female" ↑

① ARTIFICIAL POLLINATION – removed anthers from plant to be fertilised to stop self pollination + brushed pollen from selected male plant onto this "female plant" → ISOLATE (to stop accidental pollination eg cover etc.

⇒ SUCCESSFUL → he could be sure results were from intended cross.

② REPETITION – used large nos. → each cross was done with many plants, producing hundreds of offspring (reliability ↑)

⇒ SUCCESSFUL → allowed predicted probabilities to be tested. Small nos. may have not given expected ratios by chance.

③ ONE TRAIT AT A TIME (Monohybrid crosses)

37. [4 marks] *(2001:21)*

Sutton, Boveri and Morgan worked in the field of genetics.
Describe the contribution made by TWO of these scientists to the understanding of the chromosomal nature of inheritance.

BOVERI – {Crossing hybridising sea urchins (used 2 closely related species with larvae with distinct shapes). [4]

NB. When two crossed → resulting larvae had features of both parents.

EXPT (1) He removed nucleus (by shaking) → hybrids produced from sperm of species 1 and enucleated egg from eggs of s.u's from species 2 → ONLY SPECIES 1 features (shape)

Conclusion: NUCLEUS CONTROLS INHERITANCE
(Chromosomes found in nucleus ∴ chromosomes control inheritance).

Expt (2) 1 egg fertilised by 2 sperm → some larvae with 1 chrom. missing → each type had diff. feature corresponding to the chrom. that was missing.

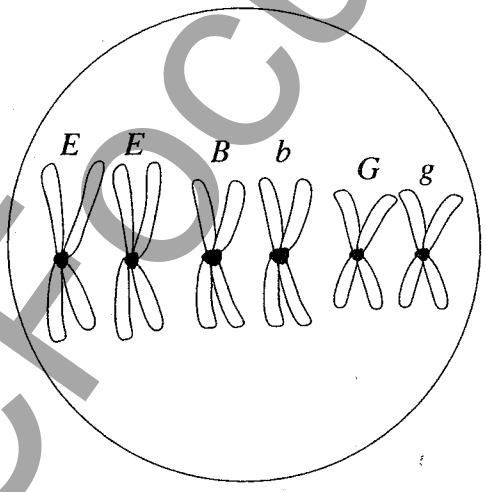
Conclusion: EACH CHROMOSOME CARRIES DIFF. GENETIC INFO.

MORGAN – breeding expts with fruit fly.

38. [4 marks] *(2002:22)*

The diagram shows a cell containing three pairs of chromosomes just prior to a *meiotic* division.

E E E E



Assuming that random segregation occurs, construct a table that lists the possible genotypes that could be produced and state the expected frequency for each genotype.

EBG, EBg, EbG, EBG, EBg, EbG, Ebg, Ebg

1 EBG : 1 EBg : 1 EbG : 1 Ebg

#37 CONT....

SUTTON - recognised that chromosomes provided a mechanism for the operation of Mendel's laws + could account for the properties of Mendel's factors, such as the segregation of alleles and the independent assortment of genes.
ie Mendel's factors were located on chromosomes.
ie GENES LOCATED ON CHROMOSOMES.

MORGAN P red eyed female × white eyed male
↓
F_1 all red eyed
↓
F_2 all females red eyed, ½ males white eyed

THEN P white eyed female × red eyed male
F_1 red eyed females + white eyed males
F_2 red + white eyed females + red + white eyed males

Conclusion: Gene producing white eyed phenotype was located on the X chromosome
→ ie provided experimental evidence linking one particular gene to one particular chromosome.
ie sex-linked OR X-linked.

54. [3 marks] *(2004:28)*

'All mutations are harmful.'

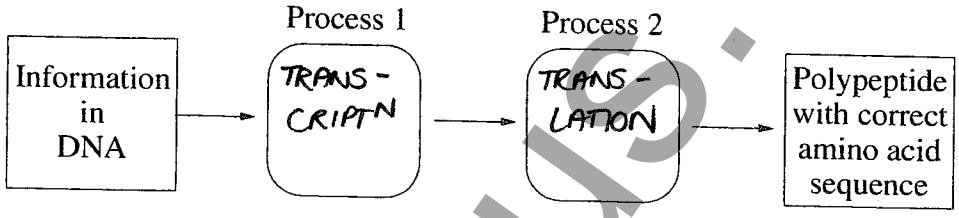
Discuss this statement.

[3]

Most mutations are harmful + do not help an organism survive in its environment. BUT sometimes, especially in a changing environment, a mutation results in a feature which helps an organism survive in its environment. This mutation (which is favourable) has a better chance of being passed on + species changes/evolves.

55. [4 marks] *(2005:18)*

This flow chart represents a model of polypeptide production



In the table below, name and outline what occurs in Processes 1 and 2

Name of process (word of phrase)	*Outline of process*
Process 1: TRANSCRIPTION	1) DNA unzipped by enzymes (exposing template) 2) mRNA nucleotides pair up to form 1 strand of mRNA
Process 2: TRANSLATION	1) mRNA moves to ribosome 2) tRNA's carry specific aa's + attach to mRNA by matching their anticodons (base triplet) to the mRNA codons. 3) peptide bonds form between adjacent amino acids.

NB. REP. TECHNOLOGIES = AI, CLONING, AP (SYLLABUS)
(WILL ACCEPT GENETIC ENGINEERING).

61. [6 marks] *(SP2001:22)*

For a NAMED species, evaluate the potential impact of the use of reproduction technologies on its diversity

NAMED SPECIES : Cattle (Bos taurus) **[6]**

AI – collecting semen from a few prize bulls + using semen to artificially inseminate a large number of cows anywhere in the world.

CLONING – producing many copies of a few prize animals using surrogate mothers

EVALUATION :

Diversity of a species in a region can by increased by bringing semen from overseas if local bulls still being used for breeding ⇒ this is good as species has better chance of survival if conditions change (like a new disease) BUT diversity could be reduced if semen from prize bulls ONLY used → less animals which reduces gene pool ie less variation which is bad as there is less chance of surviving an environmental change.

Diversity reduced with cloning but both AI + cloning may have little effect on diversity if normal sexual reproduction continues.

62. [4 marks] *(2001:16)*

Genetically modified food on menu

Australians are growing more accepting of genetically modified (GM) food, a federal agency survey has found.

This survey found that 44 per cent of Australians now believe GM food would become more widely accepted and less risky in the next few years.

An earlier survey revealed that people thought the risks outweighed the benefits, but that the situation would change.

(a) State ONE opinion held by Australians about genetically modified food, according to this article. **[1]**

GM food will become more widely accepted + less risky in the next few years.

(b) Justify ONE piece of information you would need in order to determine the validity of the survey results. **[3]**

SAMPLE SIZE – IF TOO SMALL (only a small number of people interviewed) then conclusions cannot be applied to Australians in general.

– IF A LARGER SAMPLE SIZE → it is more likely that the percentages shown in the sample are more likely to apply to all Australians

30. [8 marks] (2002:27)

Evaluate the contributions made by both Louis Pasteur and Robert Koch to our present understanding of the causes and possible prevention of infectious diseases.

[8]

PASTEUR - proposed 'Germ Theory' that microscopic airborne particles cause decay. Used swan neck flask → expt provided support for this theory. Showed that microorganisms in air could cause decay (open flask decayed while swan neck remained without decay). This was impt as disproved ideas such as spontaneous generation. Very impt as first to show that microbes cause disease (other disease causing agents like viruses + prions have since been discovered). He showed that spread of decay + disease can be stopped if you stop microbes reaching food or organisms. ⇒ PASTEURISATION (killing microbes by heating to 70°C) very impt. These methods invented by Pasteur are still used but with a much wider application.

→ led to washing of hands → sterilisation of surgical instruments
→ use of disinfectants in surgery ⇒ FAR LESS DEATH RATES AFTER OPERATIONS

KOCH - invented Koch's postulates by which the microbe which causes a particular disease can be identified eg. Anthrax in sheep

- Postulates still used today to identify causative organism in most diseases. (although it is not ethical to infect a healthy human with a disease so it is not always possible to carry out all postulates on diseases where pathogen does not produce similar symptoms in other animals)

→ VERY IMPT as without them, we would not be able to identify the cause of many infectious diseases + so we would not be able to develop a cure such as a vaccine

→ Started working on prodn of vaccines (for diseases like anthrax) but unsuccessful for producing vaccine for TB or cholera.

→ others benefited from his work + developed vaccines for many diseases.

COMMUNICATION.

#3. (c) The data in the table gives the focal length of six lenses which have the same diameter but different thickness.

Thickness of lens (mm)	*Focal length* (cm)
10	12.5
9	14.0
8	15.5
7	18.0
6	21.0
5	25.0

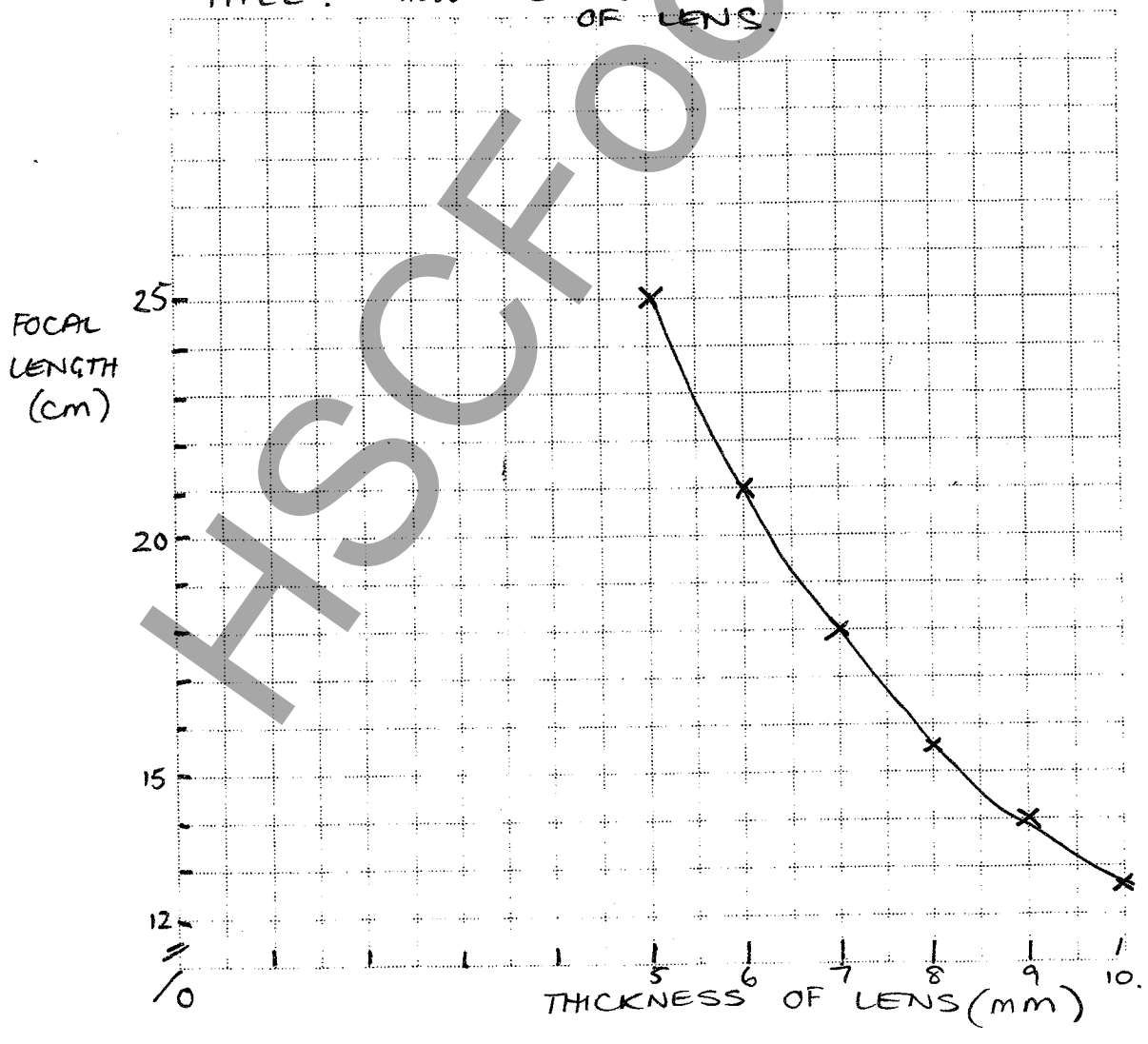
(i) Graph the data on the graph paper provided below. **[4]**

(ii) State the relationship between lens thickness and focal length.
As lens thickness increases, focal length decreases. **[1]**

(iii) Refer to the information above in explaining how human eyes can focus on objects at different distances.
Focusing on near objects requires light to be refracted more **[2]**
to ensure image focused on retina ∴ lens must be thicker to shorten focal length.

(d) The light signal reaching the retina is transformed into electrochemical signals.
SEE SEPARATE PAGE
Describe the different structures and processes in the retina that can achieve the energy transformation described above **[7]**

TITLE: HOW FOCAL LENGTH CHANGES WITH THICKNESS OF LENS.



COMMUNICATION

#3 (c) (i) GRAPH

(ii) AS LENS THICKNESS INCREASES, FOCAL LENGTH DECREASES.

(iii) Focusing on near objects requires light to be refracted more to ensure image focused on retina ∴ lens must be thicker to shorten focal length.

(d) The structures = photoreceptor cells containing light sensitive pigments.

- RODS – long rod-shaped cells around periphery of the retina.
  – contain rhodopsin which is activated by low intensity light.
  – when pupil dilated, more rods at periphery are exposed to light.
- CONES – conical cells of 3 types. They contain photopsins sensitive to blue or red or green light → concentrated in fovea.

LIGHT ENERGY ⟶ converted in these cells to ELECTROCHEMICAL energy which travels along the neurones of the optic nerve ⟶ in a wave of Na^+ moving across neurone's cell membrane ⟶ interpreted by brain.

(d) GRAPH OF COLOUR SENSITIVE PIGMENTS

(i) Three types of cones in retina – each responds to specific wavelengths. The combination of cones stimulated produces all the colours other than red, green and blue • BY COMPARING THE REL. INTENSITIES OF THE SIGNALS COMING FROM THE 3 TYPES OF CONES # • sensitivity of a particular cone cell allows it to detect light to some extent on either side of peak sensitivity, giving overlap in some of colours detected.

(ii) COLOUR BLIND – may be missing one or more types of cone OR one type of cone may not be functional.
Colour interpretation will not include that primary colour, so most colours will be misinterpreted.

(iii) Some animals, like bees can see UV part of spectrum (bees detect ≤ UV → green) as they pollinate flowers that show patterns visible with 300 – 550nm UV → they show where food found eg nectar
Bower bird – use colour (blue) to attract mates (see blue end of spectrum)

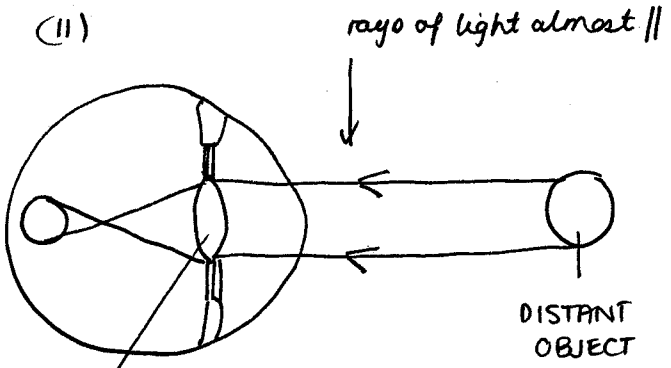
+ THE BRAIN CAN PERCEIVE OTHER COLOURS + SHADES.

PIGEONS
UV range (350 – 360 nm)
+ red, green + blue

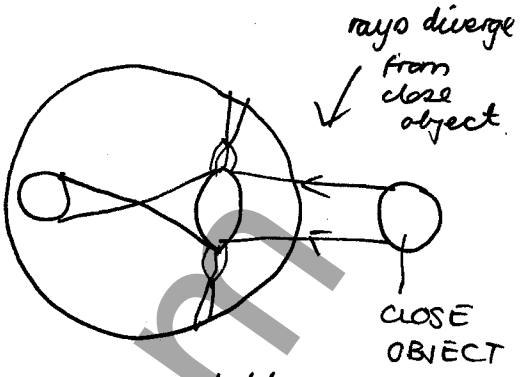
It is thought that birds use UV sensitivity in aerial navigation.

(a)(i) A = RETINA

(ii)



- elongated lens
- susp. ligaments taut
- ciliary muscles relaxed



- more rounded lens
- susp. ligaments relaxed
- ciliary muscles taut.

(b)(i) MYOPIA - short sightedness (in elderly relation)
- in old age, there is an inability to change shape of lens

(NB. WOULDN'T BE BECAUSE EYEBALL TOO LONG AS IN MYOPIA NORMALLY) OR LENS TOO THICK

CATARACTS - clouding of lens.

(ii) MYOPIA - glasses or contact lenses to ensure light focuses on retina (concave) OR laser surgery to change shape of cornea to correct focal errors.

NON-INVASIVE.

CATARACTS
- small incision surgery → NO STITCHES
- phacoemulsification of clouded lens + removal } all day surgery under local an.
- insertion of IOL to replace lens

7 (a)(i)

	RODS	CONES
FOUND	• over most of retina (but mainly periphery) NOT FOVEA	• concentrated in fovea
DIM LIGHT	• work well in dim light	• not well in dim light
COLOUR	• not sensitive to colour	• 3 types - blue, green + red.
SHAPE	• elongated, rectangular	• conical shape

(ii) rods - no role in colour-blindness

cones - red-green colour blindness → lack either cones with red sensitive opsins or the cones with green sensitive opsins ∴ cannot detect λs of light in range of visible spectrum corresponding to these colours.

⇒ CANNOT DISTINGUISH BETWEEN RED + GREEN COLOURS but have two types of cones → can see other colours.

(b) (i) MODELLING ACCOMMODATION

- Use ray box to model light reflected from object
- used two convex lenses (to represent two different shapes of eye lenses)
- fat lens modelled lens when viewing close objects + thin lens representing view distant objects.
- model how diff. focal lengths produced as accommodation occurs.
- shows that distance between lens + retina is fixed but focal length is changed.

OR exp. with 2 lenses focussing on white paper.

(ii) model show that thicker lens is needed to focus a near object + a flatter lens is needed to focus a destant object.

(C) VISION TECHNOLOGY

- Operations to remove cataracts (clouded lenses) + replace with IOLs (involve small incision, phacoemulsification + IOL)
  → people who are blind can see again which allows them to live independently without support from health system etc.
  → disadvantage: cost of operation may still be prohibitive in developing countries.

- glasses with lenses to correct vision defects such as myopia + hyperopia
  eg. concave lenses for myopia + convex lenses for hyperopia
  → allows people who have difficulty seeing to see as images can be focussed on retina → DISADVANTAGE → glasses can be broken/lost
  → cost money
- contact lenses (as above)
- laser surgery to adjust cornea to correct myopia + hyperopia
  → still surgery that may have problems.

HEARING TECHNOLOGY

- Hearing aids - amplify soft sounds so people with age related hearing loss can have normal conversation.
  → still be hard to distinguish words if there is background noise.
- Cochlear implant → restores hearing to people born deaf or who have damage to inner ear due to head injury.
  → operation expensive → possibility of infection.

(d) (i) ORGAN = EYE (NB. retina is not an organ)