UACE - UNNASE 2019

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UNNASE 2019 BIOLOGY PAPER II GUIDE;

1 a (i) Comparison of the effect of increasing light intensity on the net rate of oxygen release by the 2 plant types.

Similarities;

Net rate of oxygen release for both plant types attains a compensation point;

The net rate of oxygen release for both plants types increases with increasing light intensity or photon irradiance up to 80 µmol quanta $m^{-2}s^{-1}$;

Both plant types attain the same net rate of oxygen release at a light intensity of 100 µmol quanta $m^{-2}s^{-1}$; any 3 (03)

A maximum net rate of oxygen release was attained by both plant types.

Differences; -

Shade plant	Sun plant.
- Compensation point attained at a lower light intensity	- Compensation point attained at a higher light intensity;
- Maximum net rate of oxygen release lower.	- Maximum net rate of oxygen release higher;
- Maximum net rate of oxygen release attained at lower light intensity	- Maximum net rate of oxygen release attained at a higher light intensity;
- Net rate of oxygen release constant from light intensity of ≈ 80 µmol quanta $m^{-2}s^{-1}$.	- Net rate of oxygen release increases rapidly and then gradually from a light intensity of ≈ 80 µmol quanta $m^{-2}s^{-1}$;
- Net rate of oxygen release higher at low light intensity	- Net rate of oxygen release lower at low light intensities; any 5 (05)
- Net rate of oxygen release lower at high light intensity - Slight increase	- Net rate of oxygen release is higher at high light intensity; - Big increase in over all net rate of O_2 release;

(ii) Effect of increasing light intensity on the Sun plant.

From 0 to ≈ 80 µmol quanta $m^{-2}s^{-1}$; net rate of oxygen release increased gradually but still below compensation point; implying oxygen was consumed since the light intensity was a strong limiting factor; for photosynthesis hence causing more photolysis but oxygen used for

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respiration was more than the oxygen produced; from the slight photolysis of water in the light dependent stage of photosynthesis.
At a light intensity of ≈ 80 μmol quanta $m^{-2}s^{-1}$; the compensation point was attained; implying net rate of oxygen release was equal to net rate of oxygen consumption; implying that the photolysis rate had increased to make net rate of oxygen release and consumption to be equal.;

max 07

From approximately 100 to 400 μmol quanta $m^{-2}s^{-1}$; net rate of oxygen release increased rapidly above the compensation point; implying that light intensity was a pronounced limiting factor still; and so its increase rapidly increased the rate of photosynthesis or water photolysis hence producing more oxygen than what is consumed in respiration;
The net rate of oxygen release then increased gradually with further increase in light intensity; from ≈ 400 to 1000 μmol quanta $m^{-2}s^{-1}$; implying that light intensity was no longer the major limiting factor of photosynthesis; and instead other factors such as temperature, water, mineral salts, carbondioxide concentration and chlorophyll any concentration; were limiting the photolysis of water in photosynthesis.

iii) Suggestion and explanation for the difference in effect of increasing light intensity on the two plants:

At low light intensity, the shade plant had a higher rate of oxygen release; higher maximum rate of photosynthesis; and attained its compensation point; because shade plants are photosynthetically more efficient; at such low light intensities. This is because the shade plants possess a lower light saturation point; and are more adapted to harvest and harness low light intensity; by possessing broader leaves; and more chlorophyll since their chloroplasts possess more grana;

Sun plants on the other hand had a lower net rate of oxygen release at low light intensities, ~~due to~~ their maximum net rate of oxygen release and compensation point were attained at higher light intensities because they are photosynthetically more efficient at higher light intensities;

This is because they are adapted to harvest and harness high light intensity, due to their ~~narrow~~ thick leaves or lamina, many layers of palisade mesophyll cells, and possession of chloroplasts which take turns in bright light and shelter in others' shade as they use the absorbed light to prevent chlorophyll destruction.

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The sun plants also had a higher maximum rate of net oxygen release, and a greater effect of increasing light intensity on their net rate of oxygen release; because sun plants have a higher light saturation point than the shade plants;

b(i) Explanation for effect of increasing CO_2 concentration and temperature on net CO_2 assimilation by barley.

Increasing Carbondioxide Concentration;

The net CO_2 assimilation rate of barley increased with increase in CO_2 level or concentration because barley is a C_3 plant and increase in CO_2 level reduces the inhibitory rate of oxygen on RUBISCO; hence reducing photorespiration which is wasteful; since it produces less phosphoglycerate, utilizes ATP and $NADPH_2$ and reduces CO_2 combination with RUBISCO. The increase in CO_2 level also increases chances of collision with RUBISCO; which increases the rate of photosynthesis and hence net rate of CO_2 assimilation.

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Increasing temperature;

Increase in temperature from 5 to 15°C caused a gradual increase in net rate of CO_2 assimilation for barley plants grown in both ambient CO_2 and high CO_2 levels; due to activation of the photosynthetic enzymes; which activate photosynthesis.

Increase in temperature from 15 to 30°C caused a gradual ~~ma~~ decrease in net CO_2 assimilation rate for barley plants growing in ambient CO_2; due to the CO_2 levels limiting the assimilation rate, and more are formed which increase photorespiration; since O_2 molecules are lighter, hence collide more with temperature increase and CO_2 limitation;

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The same temperature increase caused a rapid increase in net CO_2 assimilation for Barley plants grown in high CO_2 environment;

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due to more activation of the enzymes; with CO_2 abundance and due to less or no photorespiration since the CO_2 levels are high hence competitively out competing O_2 for the active sites of RUBISCO (Ribulose bis phosphate carboxylase oxygenase).

ii) Explanation for the difference in Net CO_2 assimilation rate for maize and Barley at ambient CO_2 levels:

The Net CO_2 assimilation rate is higher for Barley at low temperatures because barley is a C_3 plant whose photosynthetic enzymes are more efficient at lower temperatures, unlike maize which is a C_4 plant whose photosynthetic enzymes are inefficient at such low temperatures.

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Increase in temperature from 20° to 30°C caused a higher net CO_2 assimilation rate in maize; due to increased efficiency of maize's photosynthetic enzymes; and decreased efficiency for Barley's photosynthetic enzymes and due to increased photorespiration in Barley plants; with such temperatures.

iii) From figure 2 why C_4 plants tend to be found in hotter more arid regions than C_3 plants;

From figure 2(two) below 15°C, net rate of CO_2 assimilation is very low for maize which is a C_4 plant; due to the low efficiency of their photosynthetic enzymes; at such temperatures hence low productivity.

As the temperatures increased above 15°C which is characteristic of hotter more arid regions, the net CO_2 assimilation rate increased rapidly; due to increased photosynthetic enzymes' activation; and hence increased photosynthesis, primary productivity and survival.

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From figure 2, C_3 plants' Net CO_2 fixation or assimilation rate was higher in temperatures below 15°C; due to high efficiency of the enzymes; and less photorespiration; and the rate of Net CO_2 assimilation decreased with increase in temperatures beyond 15°C due to reduced enzymes' activation or denaturation; and more photorespiration in such hotter conditions;

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2(a) Description of the physiological behaviour of rods during:

i) Darkness:

The rods are not stimulated; and the sodium pump in its inner segment membrane of the outer segment actively pumps out sodium ions;
Since the outer membrane is leaky; some sodium ions diffuse back into the rod; down their concentration gradient there by reducing the negative charge inside the rod which maintains the resting potential.

This results in maximum release of the neurotransmitter substance usually glutamate; at the terminal end of the rod with which it synapses with the bipolar neuron. This maintains a resting potential in the bipolar neuron; and no impulses are fired via the ganglion cells of the optic nerve;

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ii) Low light intensity;

The rods are stimulated; resulting in bleaching or isomerisation of cis retinene in rhodopsin to trans-retinene; which causes photo-decomposition of rhodopsin into opsin/scotopsin and retinene; in a process of bleaching;

This leads to development of the generator potential; up to a threshold; there by reducing the permeability of the outer membrane of the outer segment towards sodium ions; With continued active pumping of sodium ions out of the outer segment; by the sodium pump with in the inner membrane of the segment of the rod, hyperpolarisation of the rod results;

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This decreases the rate at which the neurotransmitter substance of glutamate is released at the terminal rod; leading to hyperpolarisation of the bipolar neurone; hence propagation of an action potential along the optic nerve by the ganglion cell;

iii) Exceedingly high light intensity;

The rhodopsin in the rods is over bleached; where by the rate of its photo decomposition into scotopsin/opsin and retinene is higher than the rate of re-synthesis or regeneration.;

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This renders the amount of rhodopsin insufficient; and cannot be temporarily used to focus objects in dim light; as the individual moves to low light intensity regions. 02

b) Significance of the compactness of cones at the fovea.

By being closely packed together, the cones increase visual acuity or precision; in that the images of two close objects can fall on two different cones; separated by at least one cone; which results into interpretation of images as separate units; or images by the brain; 0½ 20

3(a) Explanation for determination of:

i) ABO blood groups;

This is determined by an autosomal gene; whose locus is represented by a symbol I standing for isohaemagglutinogen;

The gene has more than three alleles or has multiple alleles; A, B and O; whereby alleles A and B are codominant; while O is recessive to both A and B;

When an individual inherits any of the following allelic combinations via fertilization; he or she tends to possess any of the 4 blood groups A, B, AB and O;

Genotype $I^A I^A$ or $I^A I^O$ determine formation of agglutinin b; or antibody in plasma and antigen/agglutinogen A; on the erythrocyte and the individual has blood group A;

Inheritance of genotype BB or BO leads to production of agglutinin a; in plasma and antigen B; on erythrocytes hence possession of blood group B;

Genotype $I^A I^B$ leads to production of both alleles A and B; on erythrocytes without agglutinins/antibodies; in plasma which render the individual to have blood group AB;

Genotypes $I^O I^O$ codes for production of agglutinins a and b; without antigens; enabling the individual to be blood group O;

(b) (ii) Sex in man;

Sex in man is determined by sex chromosomes; X and Y; carried in gametes. During fertilization, an embryo may either inherit

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XX genotype if fusing sperm contain the X-sex chromosome; XY genotype if the fusing sperm contain the Y-sex chromosome; The XX genotype determines the female homogametic sex; while the XY genotype determines the male heterogametic sex.;

Since all embryos possess an X chromosome which carries the testicular feminisation gene; for production of a protein in form of testosterone receptor, all of them have this receptor. Because the would be male embryos have a Y chromosome with a testes determining gene; for production of a protein called H-Y antigen/Testes determining factor (TDF); on the body cells of a developing male. The non differentiated gonads/genital ridges differentiate into testes/Semeniferous tubules + interstitial cells;

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Without the H-Y antigen/TDF, the non differentiated gonads differentiate into ovary of a female embryo; The developing testes of the male embryo secrete testosterone; into the blood stream which binds on the testosterone receptor to form the testosterone-receptor complex; which moves from the cytoplasm of the target cell via the nuclear pore into the nucleus and it activates the genes which code for development of the tissues which give rise to the male reproductive system; The tissues of a developing female embryo are not activated due to lack of testosterone hence a female reproductive system develops.;

b). Evolution of Charles Darwin's finches;

Originally, there was one predominant; mainland ground finch variety with short straight beaks; for seed and insects crushing.

There were few other variants of finches regarding beak shape and size; like the cactus finches with long slightly curved beak and a split tongue to feed on nectar, Insectivorous finch with parrot like beak to feed on seeds and insects, Vegetarian finch with curved parrot like beak to feed on fruits, buds and soft fruits, Warbler finch with slender beak to feed on flying insects and the wood pecker finch with large straight beak to use cactus spine to poke insects out of holes in wood; any other type.

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The high population of the finches in the main land resulted in stiff competition; for the limited resources. This caused migration of some finches to the vacant Galapagos Islands; whose niches were different especially regarding the predominant food types;
The finch varieties whose beak shapes and sizes best suited exploiting the different unique food types on the different specific Islands survived more, and reproduced more; while the less suited were selected against hence survived less;
The adaptive features in the off spring got concentrated; and with Isolation; of land-masses, gene flow between finch varieties unique to the Islands was prevented; and over generations of genetic dissimilarity; different more adapted finch species per Island were developed or arose;

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4 a) How Stratosphere is destroyed:
A Stratosphere is the upper layer of the atmosphere; 15-40 kms above the earth surface; with the Ozone layer; which absorbs short wave length radiations like ultraviolet rays, x-rays and gamma rays; from the sun and prevent them from reaching the earth surface in large amount;
Ozone is destroyed by fluorine; and chlorine radicals; from the breakdown of Chlorofluorocarbons (CFCs); using ultraviolet radiation from the sun;

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The CFCs; are used as aerosol sprays; or coolants in refrigerators; while Chloromethane; from rotting vegetation and bush burning; also react with Ozone in the Ozone layer.
When the fluorine and chlorine radicals react with Ozone in using energy from ultraviolet radiations; of sunlight, the Ozone is broken down; into molecular oxygen at a rate faster than at which it is reformed;
Bromine; also gives off radicals which react and break down ozone;
It is mainly obtained from methyl bromide used in fungicides;
Nitrogen Monoxide; from the reaction of dinitrogen oxide with atomic oxygen; using energy from U.V radiations also reacts with and

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destroys the Ozone layer;
The high flying aircraft release icy particles; in the stratosphere leading to depletion of the ozone layer;
b) Indicators to support the destruction of the stratosphere:
The large amounts of short wave length radiations; from the sun reaching the earth surface;
The more frequent change in the nucleic acids or mutations; which result into genetic diseases and abnormalities eg skin cancers.
Crop damage; which is characteristic of absorption of short wave length radiations is also common and is an indicator of ozone layer destruction.
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Regular destruction of aquatic species of organisms mainly the fish larvae and planktons; is indicative of increased short wave length radiations from the sun which is evidence of stratosphere destruction.
Reduced carbondioxide absorption by algae resulting in increased global warming is evidence of algal destruction by short wave lengths radiations from the sun hence indicative of stratosphere destruction;

c) An indicator species.
This is a species of organisms which are highly sensitive; to a certain environmental factor; whose by their presence, absence or relative numbers; reflects the level or amount of that factor in the environment; like the Lichens, are indicator species of the concentration of Sulphurdioxide in the atmosphere; Because Lichens are highly poisoned and killed by sulphurdioxide; their large population in an area reflects low levels or absence of SO_2; in the area and its low population reflects high levels of SO_2 in the area.; (Consider any appropriate other example).
Consider any of the appropriate eg.
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5 a) Modifications of Munch's theory of translocation;
Modification of Munch's theory of translocation involves the use of transfer cells, to load and unload the phloem with sugars;

At the source or mesophyll cells, the transfer cells or companion cells actively pump hydrogen ions (H^+) into the neighbouring mesophyll cells; using the hydrogen pump;

This creates a proton gradient; between the transfer and mesophyll cell; resulting in diffusion of protons from the mesophyll cells into the transfer cells; down their concentration gradient while they are being co-transported with sucrose;

This raises the osmotic influx of water into the transfer cells; and mass flow; of the solution with sucrose to move by mass flow from the transfer cells into the phloem sieve tubes; via the plasmodesmata;

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At the sink, sugars leave the sieve tubes into the transfer cells; via the plasmodesmata; from where they diffuse into the near by sink cells;

b) Stomatal movement basing on mineral ion change theory;
During the day, the stoma opens; because there is active pumping of potassium ions into the guard cells; since sunlight activates ATPase enzymes; and leads to production of large amounts of ATP; ~~two~~ in photophosphorylation whose hydrolysis avails the energy for active pumping of the potassium ions.

Increase in K^+ level, raises the osmotic pressure within the guard cells; which leads to osmotic influx of water into the guard cells; which increases their turgidity; hence opening the stoma.

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At night, the open stomata close; due to less or no sunlight to activate ATPase enzyme; and no ATP production; due to absence of photophosphorylation. The potassium ions hence diffuse out of the guard cells to the epidermal cells which causes osmotic efflux

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of water from the guard cells, to the epidermal cells thereby reducing their turgidity; hence closing the stoma.

c) Evidence that active movement of sugars in sieve tube is based on companion cells' activity;

- The sieve tubes are closely linked with companion cells, using numerous plasmodesmata; for exchange of materials.
- The linked companion cells & the sieve tube elements possess numerous mitochondria; for fast production of energy for active transport of sugars with in the tubes.
- The companion cells are highly metabolically active; more than the sieve tubes which reflects that the energy used during translocation is obtained from the companion cells.
- Treating the companion cells with metabolic poisons; reduces translocation in the sieve tubes.

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6 a) Effects of light on abundance of plants: (ie Intensity & quality).

High light intensity leads to high photosynthesis, growth and reproduction rates hence high abundance;

Low light intensity leads to low photosynthetic, growth and reproductive rates hence low abundance;

Red and blue light wavelengths stimulate more photosynthesis, more growth and reproduction rates hence high abundance;

Green light wavelength stimulate less photosynthesis hence less growth and reproduction rates resulting in less abundance;

Red light which is abundant in sun light stimulates flowering in long day plants leading to high reproductive rates and hence high abundance;

Red light inhibits flowering in short day plants leading to low reproductive rates and hence low abundance;

Far-red light stimulates flowering in short day plants thereby leading to their reproduction and high abundance;

Far-red light inhibits flowering in long day plants hence

reducing their abundance.
Exposure to longer periods of light in a 24 hour cycle inhibits flowering in short day plants hence reduce their abundance but stimulates flowering in long day plants, increases reproduction and results in high abundance;
Exposure to shorter periods of light in a 24 hour cycle stimulates flowering in short day plants, increase reproduction rates and consequent abundance but inhibits flowering in long day plants, reduce rate of reproduction and consequently reduce their abundance.
Red light induces seed germination of the positively photoblastic seeds thereby increasing their abundance;
Far-red light or darkness induces seed germination of the negatively photoblastic seeds hence increase their abundance;
Flowering and opening of flowers in some plants eg dandelion is induced by high light intensity resulting in pollination, fertilization and reproduction hence high abundance.;
High light intensity also stimulates high production of chlorophyll for maximum light absorption for high photosynthesis, growth and reproduction hence high abundance of plants.;
Exceedingly high light intensity bleaches chlorophyll molecules reducing light absorption, photosynthesis, growth, reproduction and hence abundance.;
High light intensity widely opens many stomatal pores leading to excessive water loss, low rate of photosynthesis, growth, reproduction and hence low abundance.;
Some herbivores use light to spot the plants, feed on them, reducing plant growth, reproduction and abundance;
Photoperiodism stimulates behavioural patterns like migration in birds which disperse the plant propagules increasing their abundance to places where birds have migrated.;

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b) Effect of light on morphology of plants: (NB red light = Sun light)
Red light stimulates leaf expansion in dicots while far-red light inhibits it; ✓

Red light stimulates unrolling of leaves of grasses while far-red light inhibits it. ✓

Red light stimulates chloroplast development; while far-red light inhibits it hence causes chlorosis ✓

Red light inhibits internode growth; while far-red light stimulates it

Darkness or total lack of light causes elongation of internodes; ✓ while light inhibits it.

Darkness causes development of embryonic leaves; while light stimulates growth of adult leaves. ✓ max 1[0]

Far-red light stimulates lateral roots growth; while red light inhibits lateral roots growth.

Red light stimulates greening of all plant parts while far-red light inhibits it. ✓

Red light also stimulates unhooking of plumule in dicots while far-red light inhibits it!

Blue light stimulates increase in stem diameter of plants while other light qualities have no significant effect. ✓

Blue light also causes increase in general fresh weight of the plant and other ~~ty~~ light wavelengths have no effect. ✓

Exposure of a plant to blue light quality increases stomatal frequency which thus changes morphology.

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