Grade 9 Learning Outcomes

Below are the learning outcomes of the course stating what students are expected to know/be able to do upon completion of the course.

Schoolwide Learner Outcomes

The 5 Steps Academy students develop the following global competencies (to the extent reasonable for their age group) to thrive in the unpredictable and fast-changing:

- Courage to try and make mistakes and the ability to learn from mistakes.
- Respect people regardless of their age, gender, nationality, religion, beliefs, or opinions.
- Discipline in self-development and achievement of dreams.

Mathematics

By the end of the course students should be able to:

- Solve quadratic equations and understand functions
- Graph functions and find graphical solutions
- Find arc length and area of a sector
- Understand congruence and similarly
- Calculate area and volume of similar figures and solids
- Understand and apply properties of a circle
- Find trigonometric ratios using the unit circle
- Find sin, cos and tan of special angles
- Solve trigonometric equations
- Understand properties of sine functions
- Write equations of sine functions from graphs
- Write equations of sine functions using properties
- Understand properties of cosine functions
- Write equations of cosine functions from graphs
- Write equations of cosine functions using properties
- Graph sine and cosine functions
- Draw filled table of sin, cos and tan of special angles
- Explain why sin(0°)=0 and cos(0°)=1
- Prove that tan(x)=sin(x)/cos(x)
- Solve trigonometric equations and prove trigonometric identities
- Understand conic sections

English

By the end of the course students should be able to:

- read easily, fluently and with good understanding
- develop the habit of reading widely and often, for both pleasure and information
- acquire a wide vocabulary, an understanding of grammar and knowledge of linguistic conventions for reading, writing and spoken language

- appreciate our rich and varied literary heritage
- write clearly, accurately and coherently, adapting their language and style in and for a range of contexts, purposes and audiences
- use discussion in order to learn; they should be able to elaborate and explain clearly their understanding and ideas
- are competent in the arts of speaking and listening, making formal presentations, demonstrating to others and participating in debate.

Grammar and Vocabulary:

- Memorize and correctly apply the meanings of 250 core words.
- studying their effectiveness and impact in the texts they read
- drawing on new vocabulary and grammatical constructions from their reading and listening, and using these consciously in their writing and speech to achieve particular effects
- analysing some of the differences between spoken and written language, including differences associated with formal and informal registers, and between Standard English and other varieties of English
- using linguistic and literary terminology accurately and confidently in discussing reading, writing and spoken language.

Reading

- read and appreciate the depth and power of the English literary heritage through:
    - reading a wide range of high-quality, challenging, classic literature and extended literary non-fiction, such as essays, reviews and journalism. This writing should include whole texts. The range will include:
        - at least one play by Shakespeare
        - works from the 19th, 20th and 21st centuries
        - poetry since 1789, including representative Romantic poetry
    - re-reading literature and other writing as a basis for making comparisons
    - choosing and reading books independently for challenge, interest and enjoyment.
- understand and critically evaluate texts through:
    - reading in different ways for different purposes, summarising and synthesising ideas and information, and evaluating their usefulness for particular purposes
    - drawing on knowledge of the purpose, audience for and context of the writing, including its social, historical and cultural context and the literary tradition to which it belongs, to inform evaluation
    - identifying and interpreting themes, ideas and information
    - exploring aspects of plot, characterisation, events and settings, the relationships between them and their effects
    - seeking evidence in the text to support a point of view, including justifying inferences with evidence

    - distinguishing between statements that are supported by evidence and those that are not, and identifying bias and misuse of evidence
    - analysing a writer's choice of vocabulary, form, grammatical and structural features, and evaluating their effectiveness and impact
    - making critical comparisons, referring to the contexts, themes, characterisation, style and literary quality of texts, and drawing on knowledge and skills from wider reading
- make an informed personal response, recognising that other responses to a text are possible and evaluating these.

Writing

- write accurately, fluently, effectively and at length for pleasure and information through:
    - adapting their writing for a wide range of purposes and audiences: to describe, narrate, explain, instruct, give and respond to information, and argue
    - selecting and organising ideas, facts and key points, and citing evidence, details and quotation effectively and pertinently for support and emphasis
    - selecting, and using judiciously, vocabulary, grammar, form, and structural and organisational features, including rhetorical devices, to reflect audience, purpose and context, and using Standard English where appropriate
- make notes, draft and write, including using information provided by others [e.g. writing a letter from key points provided; drawing on and using information from a presentation]
- revise, edit and proof-read through:
    - reflecting on whether their draft achieves the intended impact
    - restructuring their writing, and amending its grammar and vocabulary to improve coherence, consistency, clarity and overall effectiveness
    - paying attention to the accuracy and effectiveness of grammar, punctuation and spelling.

Public Speaking

- Speak coherently and with ease in front of a large audience.
- Use PowerPoint or other presentation software effectively, understand how to use appropriate backgrounds and the right font size for headings. bullet points, images in a way that doesn't distract from the presentation.
- Conduct sufficient research to prepare presentation.
- speak confidently, audibly and effectively, including through:
    - using Standard English when the context and audience require it
    - working effectively in groups of different sizes and taking on required roles, including leading and managing discussions, involving others productively, reviewing and summarising, and contributing to meeting goals/deadlines

- listening to and building on the contributions of others, asking questions to clarify and inform, and challenging courteously when necessary
- planning for different purposes and audiences, including selecting and organising information and ideas effectively and persuasively for formal spoken presentations and debates
- listening and responding in a variety of different contexts, both formal and informal, and evaluating content, viewpoints, evidence and aspects of presentation
- improvising, rehearsing and performing play scripts and poetry in order to generate language and discuss language use and meaning, using role, intonation, tone, volume, mood, silence, stillness and action to add impact.

Physics

By the end of the course students should be able to:

4.1 Simple phenomena of magnetism

Core

- Describe the forces between magnets, and between magnets and magnetic materials
- Give an account of induced magnetism
- Distinguish between magnetic and non-magnetic materials
- Describe methods of magnetisation, to include stroking with a magnet, use of direct current (d.c.) in a coil and hammering in a magnetic field
- Draw the pattern of magnetic field lines around a bar magnet
- Describe an experiment to identify the pattern of magnetic field lines, including the direction
- Distinguish between the magnetic properties of soft iron and steel
- Distinguish between the design and use of permanent magnets and electromagnets

Supplement

- Explain that magnetic forces are due to interactions between magnetic fields

- Describe methods of demagnetisation, to include hammering, heating and use of alternating current (a.c.) in a coil

4.2 Electrical quantities

4.2.1 Electric charge

Core

- State that there are positive and negative charges
- State that unlike charges attract and that like charges repel
- Describe simple experiments to show the production and detection of electrostatic charges
- State that charging a body involves the addition or removal of electrons
- Distinguish between electrical conductors and insulators and give typical examples

Supplement

- State that charge is measured in coulombs
- State that the direction of an electric field at a point is the direction of the force on a positive charge at that point
- Describe an electric field as a region in which an electric charge experiences a force
- Describe simple field patterns, including the field around a point charge, the field around a charged conducting sphere and the field between two parallel plates (not including end effects)
- Give an account of charging by induction
- Recall and use a simple electron model to distinguish between conductors and insulators

4.2.2 Current

Core

- State that current is related to the flow of charge
- Use and describe the use of an ammeter, both analogue and digital
- State that current in metals is due to a flow of electrons

Supplement

- Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q / t$
- Distinguish between the direction of flow of electrons and conventional current

4.2.3 Electromotive force

Core

- State that the electromotive force (e.m.f.) of an electrical source of energy is measured in volts

Supplement

- Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit

4.2.4 Potential difference

Core

- State that the potential difference (p.d.) across a circuit component is measured in volts
- Use and describe the use of a voltmeter, both analogue and digital

Supplement

- Recall that 1 V is equivalent to 1 J / C

4.2.5 Resistance

Core

- State that resistance p.d. / current and understand qualitatively how changes in p.d. or resistance affect current
- Recall and use the equation $R = V / I$
- Describe an experiment to determine resistance using a voltmeter and an ammeter

- Relate (without calculation) the resistance of a wire to its length and to its diameter

Supplement

- Sketch and explain the current–voltage characteristic of an ohmic resistor and a filament lamp
- Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross- sectional area of a wire

4.2.6 Electrical working

Core

- Understand that electric circuits transfer energy from the battery or power source to the circuit components then into the surroundings

Supplement

- Recall and use the equations P = IV and E = IVt

4.3 Electric circuits

4.3.1 Circuit diagrams

Core

- Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), heaters, thermistors, light-dependent resistors, lamps, ammeters, voltmeters, galvanometers, magnetising coils, transformers, bells, fuses and relays

Supplement

- Draw and interpret circuit diagrams containing diodes

4.3.2 Series and parallel circuits

Core

- Understand that the current at every point in a series circuit is the same
- Give the combined resistance of two or more resistors in series
- State that, for a parallel circuit, the current from the source is larger than the current in each branch

- State that the combined resistance of two resistors in parallel is less than that of either resistor by itself
- State the advantages of connecting lamps in parallel in a lighting circuit

Supplement

- Calculate the combined e.m.f. of several sources in series
- Recall and use the fact that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply
- Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit
- Calculate the effective resistance of two resistors in parallel

4.3.3 Action and use of circuit components

Core

- Describe the action of a variable potential divider (potentiometer)
- Describe the action of thermistors and light- dependent resistors and show understanding of their use as input transducers
- Describe the action of a relay and show understanding of its use in switching circuits

Supplement

- Describe the action of a diode and show understanding of its use as a rectifier
- Recognise and show understanding of circuits operating as light-sensitive switches and temperature-operated alarms (to include the use of a relay)

4.4 Digital electronics

Supplement

- Explain and use the terms analogue and digital in terms of continuous variation and high/low states
- Describe the action of NOT, AND, OR, NAND and NOR gates
- Recall and use the symbols for logic gates
- Design and understand simple digital circuits combining several logic gates

- Use truth tables to describe the action of individual gates and simple combinations of gates

4.5 Dangers of electricity

Core

- State the hazards of:
  - damaged insulation
  - overheating of cables
  - damp conditions
- State that a fuse protects a circuit
- Explain the use of fuses and circuit breakers and choose appropriate fuse ratings and circuit- breaker settings
- Explain the benefits of earthing metal cases

4.6 Electromagnetic effects

4.6.1 Electromagnetic induction

Core

- Show understanding that a conductor moving across a magnetic field or a changing magnetic field linking with a conductor can induce an e.m.f. in the conductor
- Describe an experiment to demonstrate electromagnetic induction
- State the factors affecting the magnitude of an induced e.m.f.

Supplement

- Show understanding that the direction of an induced e.m.f. opposes the change causing it
- State and use the relative directions of force, field and induced current

4.6.2 a.c. generator

Core

- Distinguish between d.c. and a.c.

Supplement

- Describe and explain a rotating-coil generator and the use of slip rings
- Sketch a graph of voltage output against time for a simple a.c. generator
- Relate the position of the generator coil to the peaks and zeros of the voltage output

4.6.3 Transformer

Core

- Describe the construction of a basic transformer with a soft-iron core, as used for voltage transformations
- Recall and use the equation

(Vp / Vs) = (Np / Ns)

- Understand the terms step-up and step-down
- Describe the use of the transformer in high- voltage transmission of electricity
- Give the advantages of high-voltage transmission

Supplement

- Describe the principle of operation of a transformer
- Recall and use the equation $I_0 V_0 = I_s V_s$

(for 100% efficiency)

- Explain why power losses in cables are lower when the voltage is high

4.6.4 The magnetic effect of a current

Core

- Describe the pattern of the magnetic field (including direction) due to currents in straight wires and in solenoids
- Describe applications of the magnetic effect of current, including the action of a relay

Supplement

- State the qualitative variation of the strength of the magnetic field over salient parts of the pattern
- State that the direction of a magnetic field line at a point is the direction of the force on the N pole of a magnet at that point
- Describe the effect on the magnetic field of changing the magnitude and direction of the current

4.6.5 Force on a current-carrying conductor

Core

- Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing:

– the current

– the direction of the field

Supplement

- State and use the relative directions of force, field and current
- Describe an experiment to show the corresponding force on beams of charged particles

4.6.6 d.c. motor

Core

- State that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by:

– increasing the number of turns on the coil

– increasing the current

– increasing the strength of the magnetic field

Supplement

- Relate this turning effect to the action of an electric motor including the action of a split-ring commutator

Chemistry

By the end of the course students should be able to:

9 The Periodic Table

9.1 The Periodic Table

Core

- Describe the Periodic Table as a method of classifying elements and its use to predict properties of elements

9.2 Periodic trends

Core

- Describe the change from metallic to non- metallic character across a period

Supplement

- Describe and explain the relationship between Group number, number of outer shell electrons and metallic/non-metallic character

9.3 Group properties

Core

- Describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point, density and reaction with water
- Predict the properties of other elements in Group I, given data, where appropriate
- Describe the halogens, chlorine, bromine and iodine in Group VII, as a collection of diatomic non-metals showing a trend in colour and density and state their reaction with other halide ions
- Predict the properties of other elements in Group VII, given data where appropriate

Supplement

- Identify trends in Groups, given information about the elements concerned

9.4 Transition elements

Core

- Describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts

Supplement

- Know that transition elements have variable oxidation states

9.5 Noble gases

Core

- Describe the noble gases, in Group VIII or 0, as being unreactive, monoatomic gases and explain this in terms of electronic structure
- State the uses of the noble gases in providing an inert atmosphere, i.e. argon in lamps, helium for filling balloons

10 Metals

10.1 Properties of metals

Core

- List the general physical properties of metals
- Describe the general chemical properties of metals, e.g. reaction with dilute acids and reaction with oxygen
- Explain in terms of their properties why alloys are used instead of pure metals
- Identify representations of alloys from diagrams of structure

10.2 Reactivity series

Core

- Place in order of reactivity: potassium, sodium, calcium, magnesium, zinc, iron, (hydrogen) and copper, by reference to the reactions, if any, of the metals with:

– water or steam

– dilute hydrochloric acid

and the reduction of their oxides with carbon

- Deduce an order of reactivity from a given set of experimental results

Supplement

- Describe the reactivity series as related to the tendency of a metal to form its positive ion, illustrated by its reaction, if any, with:

– the aqueous ions

– the oxides

of the other listed metals

- Describe and explain the action of heat on the hydroxides, carbonates and nitrates of the listed metals

- Account for the apparent unreactivity of aluminium in terms of the oxide layer which adheres to the metal

10.3 Extraction of metals

Core

- Describe the ease in obtaining metals from their ores by relating the elements to the reactivity series

- Describe and state the essential reactions in the extraction of iron from hematite

- Describe the conversion of iron into steel using basic oxides and oxygen

- Know that aluminium is extracted from the ore bauxite by electrolysis
- Discuss the advantages and disadvantages of recycling metals, limited to iron/steel and aluminium

Supplement

- Describe in outline, the extraction of zinc from zinc blende
- Describe in outline, the extraction of aluminium from bauxite including the role of cryolite and the reactions at the electrodes

10.4 Uses of metals \

Core

- Name the uses of aluminium:

– in the manufacture of aircraft because of its strength and low density

– in food containers because of its resistance to corrosion

- Name the uses of copper related to its properties (electrical wiring and in cooking utensils)
- Name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)

Supplement

- Explain the uses of zinc for galvanising and for making brass
- Describe the idea of changing the properties of iron by the controlled use of additives to form steel alloys

11 Air and water

11.1 Water

Core

- Describe chemical tests for water using cobalt(II) chloride and copper(II) sulfate
- Describe, in outline, the treatment of the water supply in terms of filtration and chlorination
- Name some of the uses of water in industry and in the home

Supplement

- Discuss the implications of an inadequate supply of water, limited to safe water for drinking and water for irrigating crops

11.2 Air

Core

- State the composition of clean, dry air as being approximately 78% nitrogen, 21% oxygen and the remainder as being a mixture of noble gases and carbon dioxide
- Name the common pollutants in the air as being carbon monoxide, sulfur dioxide, oxides of nitrogen and lead compounds
- State the source of each of these pollutants:

– carbon monoxide from the incomplete combustion of carbon-containing substances

– sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds (leading to ‘acid rain’)

– oxides of nitrogen from car engines

– lead compounds from leaded petrol

- State the adverse effect of these common pollutants on buildings and on health and discuss why these pollutants are of global concern
- State the conditions required for the rusting of iron
- Describe and explain methods of rust prevention, specifically paint and other coatings to exclude oxygen

Supplement

- Describe the separation of oxygen and nitrogen from liquid air by fractional distillation

- Describe and explain the presence of oxides of nitrogen in car engines and their catalytic removal

- Describe and explain sacrificial protection in terms of the reactivity series of metals and galvanising as a method of rust prevention

11.3 Nitrogen and fertilisers

Core

- Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers

- Describe the displacement of ammonia from its salts

Supplement

- Describe and explain the essential conditions for the manufacture of ammonia by the Haber process including the sources of the hydrogen and nitrogen, i.e. hydrocarbons or steam and air

11.4 Carbon dioxide and methane

Core

- State that carbon dioxide and methane are greenhouse gases and explain how they may contribute to climate change

- State the formation of carbon dioxide:

– as a product of complete combustion of carbon-containing substances

– as a product of respiration

– as a product of the reaction between an acid and a carbonate

– from the thermal decomposition of a carbonate

- State the sources of methane, including decomposition of vegetation and waste gases from digestion in animals

Supplement

- Describe the carbon cycle, in simple terms, to include the processes of combustion, respiration and photosynthesis

12 Sulfur

12.1 Sulfur

Core

- Name some sources of sulfur
- Name the use of sulfur in the manufacture of sulfuric acid
- State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)

Supplement

- Describe the manufacture of sulfuric acid by the Contact process, including essential conditions and reactions
- Describe the properties and uses of dilute and concentrated sulfuric acid

13 Carbonates

13.1 Carbonates

Core

- Describe the manufacture of lime (calcium oxide) from calcium carbonate

(limestone) in terms of thermal decomposition

- Name some uses of lime and slaked lime such as in treating acidic soil and neutralising acidic industrial waste products, e.g. flue gas desulfurisation
- Name the uses of calcium carbonate in the manufacture of iron and cement

Biology

By the end of the course students should be able to:

16 Reproduction

Core

- Define asexual reproduction as a process resulting in the production of genetically identical offspring from one parent
- Identify examples of asexual reproduction from information provided

Supplement

- Discuss the advantages and disadvantages of asexual reproduction:

– to a population of a species in the wild

– to crop production

Core

- Define sexual reproduction as a process involving the fusion of the nuclei of two gametes (sex cells) to form a zygote and the production of offspring that are genetically different from each other
- Define fertilisation as the fusion of gamete nuclei

Supplement

- State that the nuclei of gametes are haploid and that the nucleus of a zygote is diploid
- Discuss the advantages and disadvantages of sexual reproduction:

– to a population of a species in the wild

– to crop production

Core

- Identify and draw, using a hand lens if necessary, the sepals, petals, stamens, filaments and anthers, carpels, style, stigma, ovary and ovules, of an insect-pollinated flower

- State the functions of the sepals, petals, anthers, stigmas and ovaries

- Use a hand lens to identify and describe the anthers and stigmas of a wind-pollinated flower

- Distinguish between the pollen grains of insect-pollinated and wind-pollinated flowers

- Define pollination as the transfer of pollen grains from the anther to the stigma

- State that fertilisation occurs when a pollen nucleus fuses with a nucleus in an ovule

- Describe the structural adaptations of

insect-pollinated and wind-pollinated flowers

- Investigate and state the environmental conditions that affect germination of seeds, limited to the requirement for water, oxygen and a suitable temperature

Supplement

- Define self-pollination as the transfer of pollen grains from the anther of a flower to the stigma of the same flower or different flower on the same plant

- Define cross-pollination as transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species

- Discuss the implications to a species of

self-pollination and cross-pollination in terms of variation, capacity to respond to changes in the environment and reliance on pollinators

- Describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (details of production of endosperm and development are not required)

Core

- Identify and name on diagrams of the male reproductive system: the testes, scrotum, sperm ducts, prostate gland, urethra and penis, and state the functions of these parts

- Identify and name on diagrams of the female reproductive system: the ovaries, oviducts, uterus, cervix and vagina, and state the functions of these parts

- Describe fertilisation as the fusion of the nuclei from a male gamete (sperm) and a female gamete (egg cell/ovum)

- State the adaptive features of sperm, limited to flagellum and the presence of enzymes

- State the adaptive features of egg cells, limited to energy stores and a jelly coating that changes after fertilisation

- State that in early development, the zygote forms an embryo which is a ball of cells that implants into the wall of the uterus

- State the functions of the umbilical cord, placenta, amniotic sac and amniotic fluid

- Outline the growth and development of the fetus in terms of increasing complexity in the early stages and increasing size towards the end of pregnancy

- Describe the antenatal care of pregnant women, limited to special dietary needs and the harm from smoking and alcohol consumption

- Outline the processes involved in labour and birth, limited to:

– breaking of the amniotic sac

– contraction of the muscles in the uterus wall

– dilation of the cervix

– passage through the vagina

– tying and cutting the umbilical cord

– delivery of the afterbirth

Supplement

- Compare male and female gametes in terms of size, structure, motility and numbers

- Explain the adaptive features of sperm, limited to flagellum, mitochondria and enzymes in the acrosome

- Explain the adaptive features of egg cells, limited to energy stores and the jelly coat that changes at fertilisation

- Describe the function of the placenta and umbilical cord in relation to exchange of dissolved nutrients, gases and excretory products and providing a barrier to toxins and pathogens (structural details are not required)

- State that some toxins, e.g. nicotine, and pathogens, e.g. rubella virus, can pass across the placenta and affect the fetus

- Discuss the advantages and disadvantages of breast-feeding compared with bottle-feeding using formula milk

Core

- Describe the roles of testosterone and oestrogen in the development and regulation of secondary sexual characteristics during puberty

- Describe the menstrual cycle in terms of changes in the ovaries and in the lining of the uterus

Supplement

- Describe the sites of production of oestrogen and progesterone in the menstrual cycle and in pregnancy

- Explain the role of hormones in controlling the menstrual cycle and pregnancy, limited to FSH, LH, progesterone and oestrogen

Core

- Outline the following methods of birth control:

– natural, limited to abstinence, monitoring body temperature and cervical mucus

– chemical, limited to IUD, IUS, contraceptive pill, implant and injection

– barrier, limited to condom, femidom, diaphragm

– surgical, limited to vasectomy and female sterilisation

Supplement

- Outline the use of hormones in contraception and fertility treatments

- Outline artificial insemination (AI)

- Outline in vitro fertilisation (IVF)

- Discuss the social implications of contraception and fertility treatments

Core

- Define sexually transmitted infection as an infection that is transmitted via body fluids through sexual contact
- State that human immunodeficiency virus (HIV) is an example of an STI
- Explain how the spread of STIs is controlled
- Describe the methods of transmission of HIV
- State that HIV infection may lead to AIDS

Supplement

- Outline how HIV affects the immune system, limited to decreased lymphocyte numbers and reduced ability to produce antibodies

17 Inheritance

Core

- Define inheritance as the transmission of genetic information from generation to generation

Core

- Define chromosome as a thread-like structure of DNA, carrying genetic information in the form of genes
- Define gene as a length of DNA that codes for a protein
- Define allele as a version of a gene
- Describe the inheritance of sex in humans with reference to XX and XY chromosomes

Supplement

- Explain that the sequence of bases in a gene is the genetic code for putting together amino acids in the correct order to make a specific protein (knowledge of the details of nucleotide structure is not required)

- Explain that DNA controls cell function by controlling the production of proteins (some of which are enzymes), antibodies and receptors for neurotransmitters

- Explain how a protein is made, limited to:

– the gene coding for the protein remains in the nucleus

– mRNA molecules carry a copy of the gene to the cytoplasm

– the mRNA passes through ribosomes

– the ribosome assembles amino acids into protein molecules

– the specific order of amino acids is determined by the sequence of bases in the mRNA (knowledge of the details of transcription or translation is not required)

- Explain that all body cells in an organism contain the same genes, but many genes in a particular cell are not expressed because the cell only makes the specific proteins it needs

- Define a haploid nucleus as a nucleus containing a single set of unpaired chromosomes, e.g. in gametes

- Define a diploid nucleus as a nucleus containing two sets of chromosomes, e.g. in body cells

- State that in a diploid cell, there is a pair of each type of chromosome and in a human diploid cell there are 23 pairs

Core

- Define mitosis as nuclear division giving rise to genetically identical cells (details of stages are not required)

- State the role of mitosis in growth, repair of damaged tissues, replacement of cells and asexual reproduction

Supplement

- State that the exact duplication of chromosomes occurs before mitosis

- State that during mitosis, the copies of chromosomes separate, maintaining the chromosome number (details of stages of mitosis are not required)

- Describe stem cells as unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

Core

- Define meiosis as nuclear division giving rise to cells that are genetically different (details of stages are not required)

- State that meiosis is involved in the production of gametes

Supplement

- Define meiosis as reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells (details of stages are not required)

- Explain how meiosis produces variation by forming new combinations of maternal and paternal chromosomes (specific details are not required)

Core

- Define genotype as the genetic make-up of an organism in terms of the alleles present

- Define phenotype as the observable features of an organism

- Define homozygous as having two identical alleles of a particular gene

- State that two identical homozygous individuals that breed together will be pure-breeding

- Define heterozygous as having two different alleles of a particular gene

- State that a heterozygous individual will not be pure-breeding

- Define dominant as an allele that is expressed if it is present

- Define recessive as an allele that is only expressed when there is no dominant allele of the gene present

- Interpret pedigree diagrams for the inheritance of a given characteristic

- Use genetic diagrams to predict the results of monohybrid crosses and calculate phenotypic ratios, limited to 1:1 and 3:1 ratios

- Use Punnett squares in crosses which result in more than one genotype to work out and show the possible different genotypes

Supplement

- Explain how to use a test cross to identify an unknown genotype

- Explain co-dominance by reference to the inheritance of ABO blood groups – phenotypes being A, B, AB and O blood groups and alleles being IA, IB and IO

- Define a sex-linked characteristic as a characteristic in which the gene responsible is located on a sex chromosome and that this

makes it more common in one sex than in the other

- Describe colour blindness as an example of sex linkage

- Use genetic diagrams to predict the results of monohybrid crosses involving co-dominance or sex linkage and calculate phenotypic ratios

18 Variation and selection

Core

- Define variation as differences between individuals of the same species

- Distinguish between phenotypic variation and genetic variation

- State that continuous variation results in a range of phenotypes between two extremes, e.g. height in humans

- State that discontinuous variation results in a limited number of phenotypes with no intermediates, e.g. tongue rolling

- Record and present the results of investigations into continuous and discontinuous variation

- Define mutation as genetic change

- State that mutation is the way in which new alleles are formed

- State that ionising radiation and some chemicals increase the rate of mutation

Supplement

- State that phenotypic variation is caused by both genetic and environmental factors
- State that discontinuous variation is mostly caused by genes alone, e.g. A, B, AB and O blood groups in humans
- Define gene mutation as a change in the base sequence of DNA
- Describe the symptoms of sickle-cell anaemia
- Explain how a change in the base sequence of the gene for haemoglobin results in abnormal haemoglobin and sickle-shaped red blood cells
- Use genetic diagrams to show how sickle-cell anaemia is inherited
- State that people who are heterozygous (HbS HbA) for the sickle-cell allele have a resistance to malaria
- Explain the distribution of the sickle-cell allele in human populations with reference to the distribution of malaria

Core

- Define adaptive feature as an inherited feature that helps an organism to survive and reproduce in its environment
- Interpret images or other information about a species to describe its adaptive features

Supplement

- Define adaptive feature as the inherited functional features of an organism that increase its fitness
- Define fitness as the probability of an organism surviving and reproducing in the environment in which it is found
- Explain the adaptive features of hydrophytes and xerophytes to their environments

Core

- Describe natural selection with reference to:

– variation within populations

– production of many offspring

– competition for resources

– struggle for survival

– reproduction by individuals that are better adapted to the environment than others

– passing on of their alleles to the next generation

- Describe selective breeding with reference to:

– selection by humans of individuals with desirable features

– crossing these individuals to produce the next generation

– selection of offspring showing the desirable features

Supplement

- Describe evolution as the change in adaptive features of a population over time as the result of natural selection

- Define the process of adaptation as the process, resulting from natural selection, by which populations become more suited to their environment over many generations

- Describe the development of strains of antibiotic resistant bacteria as an example of evolution by natural selection

- State the differences between natural and artificial selection

- Outline how selective breeding by artificial selection is carried out over many generations to improve crop plants and domesticated animals

19 Organisms and their environment

Core

- State that the Sun is the principal source of energy input to biological systems

Supplement

- Describe the flow of energy through living organisms including light energy from the Sun and chemical energy in organisms and its eventual transfer to the environment

Core

- Define a food chain as showing the transfer of energy from one organism to the next, beginning with a producer
- State that energy is transferred between organisms in a food chain by ingestion
- Construct simple food chains

Supplement

- Describe how energy is transferred between trophic levels
- Define trophic level as the position of an organism in a food chain, food web, pyramid of numbers or pyramid of biomass
- Explain why the transfer of energy from one trophic level to another is inefficient
- Explain why food chains usually have fewer than five trophic levels continued

Core

- Define a food web as a network of interconnected food chains
- Define producer as an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis
- Define consumer as an organism that gets its energy by feeding on other organisms
- State that consumers may be classed as primary, secondary and tertiary according to their position in a food chain
- Define herbivore as an animal that gets its energy by eating plants
- Define carnivore as an animal that gets its energy by eating other animals
- Define decomposer as an organism that gets its energy from dead or waste organic material

- Interpret food chains and food webs in terms of identifying producers and consumers
- Use food chains and food webs to describe the impacts humans have through over-harvesting of food species and through introducing foreign species to a habitat
- Draw, describe and interpret pyramids of numbers

Supplement

- Explain why there is a greater efficiency in supplying plants as human food, and that there is a relative inefficiency in feeding crop plants to livestock that will be used as food
- Identify producers, primary consumers, secondary consumers, tertiary consumers and quaternary consumers as the trophic levels in food webs, food chains, pyramids of numbers and pyramids of biomass
- Draw, describe and interpret pyramids of biomass
- Discuss the advantages of using a pyramid of biomass rather than a pyramid of numbers to represent a food chain

Core

- Describe the carbon cycle, limited to photosynthesis, respiration, feeding, decomposition, fossilisation and combustion
- Discuss the effects of the combustion of fossil fuels and the cutting down of forests on the carbon dioxide concentrations in the atmosphere
- Describe the water cycle, limited to evaporation, transpiration, condensation and precipitation

Supplement

- Describe the nitrogen cycle in terms of:

– decomposition of plant and animal protein to ammonium ions

– nitrification

– nitrogen fixation by lightning and bacteria

– absorption of nitrate ions by plants

– production of amino acids and proteins

– feeding and digestion of proteins

– deamination

– denitrification

• State the roles of microorganisms in the nitrogen cycle, limited to decomposition, nitrification, nitrogen fixation and denitrification (generic names of individual bacteria, e.g. Rhizobium, are not required)

Core

• Define population as a group of organisms of one species, living in the same area, at the same time

• Identify and state the factors affecting the rate of population growth for a population of an organism, limited to food supply, predation and disease

• Discuss the increase in human population size over the past 250 years and its social and environmental implications

• Interpret graphs and diagrams of human population growth

Supplement

• Define community as all of the populations of different species in an ecosystem

• Define ecosystem as a unit containing the community of organisms and their environment, interacting together, e.g. a decomposing log, or a lake

• Identify the lag, exponential (log), stationary and death phases in the sigmoid population growth curve for a population growing in an environment with limited resources

• Explain the factors that lead to each phase in the sigmoid curve of population growth, making reference, where appropriate, to the role of limiting factors

20 Biotechnology and genetic engineering

Core

- State that bacteria are useful in biotechnology and genetic engineering due to their rapid reproduction rate and their ability to make complex molecules

Supplement

- Discuss why bacteria are useful in biotechnology and genetic engineering, limited to:
  - lack of ethical concerns over their manipulation and growth
  - genetic code shared with all other organisms
  - presence of plasmids

Core

- Describe the role of anaerobic respiration in yeast during production of ethanol for biofuels
- Describe the role of anaerobic respiration in yeast during bread-making
- Investigate and describe the use of pectinase in fruit juice production
- Investigate and describe the use of biological washing powders that contain enzymes

Supplement

- Investigate and explain the use of lactase to produce lactose-free milk
- Describe the role of the fungus Penicillium in the production of the antibiotic penicillin
- Explain how fermenters are used in the production of penicillin

Core

- Define genetic engineering as changing the genetic material of an organism by removing, changing or inserting individual genes
- State examples of genetic engineering:
  - the insertion of human genes into bacteria to produce human insulin

– the insertion of genes into crop plants to confer resistance to herbicides

– the insertion of genes into crop plants to confer resistance to insect pests

– the insertion of genes into crop plants to provide additional vitamins

Supplement

• Outline genetic engineering using bacterial production of a human protein as an example, limited to:

– isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends

– cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends

– insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid

– insertion of plasmid into bacteria (specific detail is not required)

– replication of bacteria containing recombinant plasmids which make human protein as they express the gene

• Discuss the advantages and disadvantages of genetically modifying crops, such as soya, maize and rice

21 Human influences on ecosystems

Core

• State how modern technology has resulted in increased food production in terms of:

– agricultural machinery to use larger areas of land and improve efficiency

– chemical fertilisers to improve yields

– insecticides to improve quality and yield

– herbicides to reduce competition with weeds

– selective breeding to improve production by crop plants and livestock, e.g. cattle, fish and poultry

- Describe the negative impacts to an ecosystem of large-scale monocultures of crop plants
- Describe the negative impacts to an ecosystem of intensive livestock production

Supplement

- Discuss the social, environmental and economic implications of providing sufficient food for an increasing human global population
- Discuss the problems which contribute to famine including unequal distribution of food, drought and flooding, increasing population and poverty

Core

- Describe the reasons for habitat destruction, limited to:

– increased area for food crop growth, livestock production and housing

– extraction of natural resources

– marine pollution

- State that through altering food webs and food chains, humans can have a negative impact on habitats
- List the undesirable effects of deforestation as an example of habitat destruction, to include extinction, loss of soil, flooding and increase of carbon dioxide in the atmosphere

Supplement

- Explain the undesirable effects of deforestation on the environment

Core

- State the sources and effects of pollution of land and water, e.g. rivers, lakes and the sea, by insecticides, herbicides and by nuclear fall-out
- State the sources and effects of pollution of water (rivers, lakes and the sea) by chemical waste, discarded rubbish, untreated sewage and fertilisers

- State the sources and effects of pollution of the air by methane and carbon dioxide, limited to the enhanced greenhouse effect and climate change

Supplement

- Explain the process of eutrophication of water in terms of:

– increased availability of nitrate and other ions

– increased growth of producers

– increased decomposition after death of producers

– increased aerobic respiration by decomposers

– reduction in dissolved oxygen

– death of organisms requiring dissolved oxygen in water

- Discuss the effects of non-biodegradable plastics in the environment, in both aquatic and terrestrial ecosystems

- Discuss the causes and effects on the environment of acid rain

- State the measures that are taken to reduce sulfur dioxide pollution and reduce the impact of acid rain

- Explain how increases in carbon dioxide and methane concentrations in the atmosphere cause an enhanced greenhouse effect that leads to climate change

- Describe the negative impacts of female contraceptive hormones in water courses, limited to reduced sperm count in men and feminisation of aquatic organisms

Core

- Define a sustainable resource as one which is produced as rapidly as it is removed from the environment so that it does not run out

- Explain the need to conserve non-renewable resources, limited to fossil fuels

- State that some resources can be maintained, limited to forests and fish stocks

- State that products can be reused or recycled, limited to paper, glass, plastic and metal

- Outline how sewage is treated to make the water that it contains safe to return to the environment or for human use

- Explain why organisms become endangered or extinct, limited to climate change, habitat destruction, hunting, pollution and introduced species

- Describe how endangered species can be conserved, limited to monitoring and protecting species and habitats, education, captive breeding programmes and seed banks

Supplement

- Define the term sustainable development as development providing for the needs of an increasing human population without harming the environment

- Explain how forests and fish stocks can be sustained using education, legal quotas and restocking

- Explain that sustainable development requires:

– management of conflicting demands

– planning and co-operation at local, national and international levels

- Explain the risks to a species if the population size drops, reducing variation (knowledge of genetic drift is not required)

- Explain reasons for conservation programmes, to include:

– reducing extinction

– protecting vulnerable environments

– maintaining ecosystem functions, limited to nutrient cycling and resource provision, e.g. food, drugs, fuel and genes

Modern History

By the end of the course students should be able to answer the following questions:

- Were the peace treaties of 1919–23 fair?

- To what extent was the League of Nations a success?

- Why had international peace collapsed by 1939?

• Who was to blame for the Cold War?

• How effectively did the United States contain the spread of Communism?

• How secure was the USSR's control over Eastern Europe, 1948–c.1989?

• Why did events in the Gulf matter, c.1970–2000?

Students should be able to:

- recall, select, organise and deploy knowledge of the syllabus content.
- construct historical explanations using an understanding of:

• cause and consequence, change and continuity, similarity and difference

• the motives, emotions, intentions and beliefs of people in the past.

- understand, interpret, evaluate and use a range of sources as evidence, in their historical context.

Art History

By the end of the course students should be able to:

1 - Describe Art Principles and History

2 - Demonstrate an understanding of the Art of the Ancient World

3 - Demonstrate an understanding of the Art of the Medieval World

4 - Demonstrate an understanding of the Early Modern World

US History

By the end of the course students are expected to develop the following skills

- Making historical connections,
- Chronological reasoning (causation),
- Creating and supporting a historical argument.

and should be able to demonstrate an understanding of the following content areas:

Period 1: 1491-1607

Native American societies before contact

European exploration in the Americas

Columbian Exchange, Spanish exploration, and conquest

Labor, slavery, and caste in the Spanish colonial system

Cultural interactions between Europeans, Native Americans, and Africans

Period 2: 1607-1754

European colonization

Regions of British colonies

Transatlantic trade

Interactions between American Indians and Europeans

Slavery in the British colonies

Colonial society and culture

Period 3: 1754-1800

The Seven Years' War (The French and Indian War)

Taxation without representation

Philosophical foundations of the American Revolution

The American Revolution

The influence of revolutionary ideals

The Articles of Confederation

The Constitutional Convention and debates over ratification

The Constitution

Shaping a new republic

Developing an American identity

Movement in the early republic

Period 4: 1800-1848

The rise of political parties and the era of Jefferson

Politics and regional interests

America on the world stage

Market Revolution: industrialization

Market Revolution: society and culture

Expanding democracy

Jackson and federal power

The development of an American culture

The Second Great Awakening

An age of reform

African Americans in the early republic

The society of the South in the early republic

Literature

By the end of the course students should be able to demonstrate the following:

• knowledge of the content of the text – through reference to detail and use of quotations from the text

• understanding of characters, relationships, situations and themes

• understanding of the writer's intentions and methods – response to the writer's use of language

• personal response – sometimes directly (answering questions such as 'What do you think?', 'What are your feelings about...?') and sometimes by implication (answering questions such as 'Explore the ways in which...')

Geography

By the end of the course students should be able to demonstrate the knowledge and understanding of:

• the wide range of processes, including human actions, contributing to the development of

(a) physical, economic and social environments and their effects on the landscape

(b) spatial patterns and interactions which are important within these environments

• the relationships between human activity and the environment

• the importance of scale (whether local, regional or global)

• the changes which occur through time in places, landscapes and spatial distribution.

Students should be able to:

• interpret and analyse geographical data

• use and apply geographical knowledge and understanding to maps and in numerical, diagrammatic, pictorial, photographic and graphical form

• use geographical data to recognise patterns in such data and to deduce relationships

• select and show understanding of techniques for observing and collecting data

• select and use techniques for organising and presenting data.

• reason and make judgements and decisions, including evaluation and conclusions, which demonstrate, where appropriate

(a) an appreciation of the attitudes, values and beliefs of others in issues which have a geographical dimension

(b) an awareness of the contrasting opportunities and constraints of people living in different places and under different physical and human conditions

(c) a willingness to review their own attitudes in the light of the views of others and new knowledge acquired

• make judgements and decisions and recognise how these are made within a geographical context as affected and constrained by

(a) the physical and human contexts in which decisions are made

(b) the values and perceptions of differing groups or individuals

(c) the choices available to decision-makers

(d) the increasing level of global interdependence and the need for sustainable development.

Economics

By the end of the course students should be able to:
• show knowledge and understanding of economic definitions, formulas, concepts and theories
• use economic terminology.
• select, organise and interpret data
• use economic information and data to recognise patterns and to deduce relationships
• apply economic analysis to written, numerical, diagrammatic and graphical data
• analyse economic issues and situations, identifying and developing links.
• evaluate economic information and data
• distinguish between economic analysis and unreasoned statements
• recognise the uncertainties of the outcomes of economic decisions and events
• communicate economic thinking in a logical manner.