Module: Chemistry – Building Blocks, Complex Molecules & Mixtures

- **Curriculum:** Science
- **Year:** 8*
- **Stream:** Science Understanding
- **Biological Sciences:** *Classify matter as elements, compounds or mixtures and compare different representations of these, including 2-dimensional and 3-dimensional models, symbols for elements and formulas for molecules and compounds*
- **CD Code & Link** AC9S8U06
- **Cross-curriculum priority** link: Aboriginal & Torres Strait Islander Histories & Culture

***Cross-subject linkages** for other secondary subjects include: STEM electives, Food Technology, Food & Fibre, Biology.

Chemistry module outline

Background: This year 8 chemistry module will cover the below content elaborations drawing upon examples from biology, food systems and materials.
 	
Part 1: Building blocks
• **Unpacking molecules**- theory and application
    o Background: Atoms, atomic mass, molecular formular, molecular weight.
    o Examples: Simple & more complex molecules
    o Examples: Building blocks of food & materials
• Use **virtual, visual and physical models** to distinguish between elements and compounds in terms of types of atoms
 	
Part 2: Mixtures from food systems
• **Use representations** to show the classification of matter as elements, compounds and different types of mixtures such as solutions, suspensions and colloids
• **Food systems – the chemistry of different types of mixtures** such as solutions, suspensions and colloids

External resources:

There is opportunity to draw upon First Nations chemistry and culture examples, including via the free learning resource from **Australians Together**'s module **Separating mixtures:**

- **Cross-curriculum priority** link: Aboriginal & Torres Strait Islander Histories & Culture
  - Access free resource: https://australianstogether.org.au/curriculum-resources/#Year7
  - Teacher guide
  - Student handouts

Part 1: Building blocks

Content: Atoms, atomic mass, molecular formula & molecular weight.

Examples of concepts and lesson flow include:

- **Atoms – fundamental structure:**
  - **Optional: Revision and/or pre-test –** educator may utilise to discover the current understanding of class stands regarding atomic structure and the periodic table. This could entail a class room discussion (general discussion with open questions), or a more structured questionnaire or worksheet that contains the core components of the atomic structure content and periodic table basics (e.g., structure of the periodic table, the act of locating an element in the period table & interpreting details of the proton, atomic weight and groups etc.).

  Chemistry refresher could include:

  - **Structure of the atom & its nucleus** (the centre of an atom contains protons and neutrons). Protons are positively charged. Neutrons are neutral in charge.
  - **Electrons:** Surrounding the nucleus are electrons (negatively-charged particles) that orbit around the nuclear in shells.
  - **Atomic number** = protons in the nucleus. The number of **protons** defines the identity of an element.
  - **Protons & electrons relationship:** A stable **neutral element** has an equal number of protons (positively charged particle) and electrons (negative charged particle). Therefore, the total electrical charge of the atom is zero ('neutral'). Example: Carbon as a stable element has 6 protons in its nucleus, and 6 electrons orbiting this within its shells.
  - **Atomic weight =** total mass of the protons and neutrons in an atom's nucleus.
  - **Isotopes:** Different numbers of **neutrons** make different isotopes of an element (essentially different 'flavours' of an atom).
  - Elemental example could be **Carbon**: this element has 6 protons (atomic number 6 of periodic table). The nucleus can contain 6 neutrons as well = atomic weight i.e., 6+6 = 12 **atomic mass units (amu)** or **grams per mole (g/mol)** approx. This is the isotope for Carbon-12.
  - Show & discuss how this particular isotope information is written: ^{12}C (formalities of writing the isotope number in the top left above the elemental symbol). Further the example by discussion Carbon-13 (^{13}C) – this contains the 6 protons to make it Carbon, but has 7 neutrons, so totals 13 amu or g/mol. The isotope ^{13}C is used for carbon dating and it is radioactive – slowly undergoing decay over time, allowing the dating of archaeological material.
- **Units of mass** – Applies for: atoms of an element, ions & molecules. The mass of 1 mole (atomic unit) in grams per mole. Atomic mass units are analogous to this.

- **Extension: Concept of a mole** (what is this?). Moles = 'n'. include Avogadros Number (short-hand symbol: N_A) – value is: 6.02 x 10^{23} (a huge number!) – the **amount** of particles in a mole. This could be the number of atoms in a mole for atoms. *For molecules, this is the number of* *molecules in a mole).* The measurement 'mole' can be used as a quantity as well: for example, *"2 moles of carbon"*. This allows you to also calculate how many atoms there are within this quantity of moles using Avogadro's Number (N_A).

- **Extension**: **Simple mole calculation-** the number of moles of a particular species = (grams per species/ mass of the species). Applies to atoms of an element, or to larger overall molecule. This enables us to calculate the number of moles (n) of a substance in a particular mass. Chemistry has different units, used to describe amounts of different substances.
  - **Units:** Mass is in grams, moles (n) is moles, molecular or atomic weight is grams per mole.
  - **Atoms:** (n = mass/AW)
  - **Molecules:** (n = mass/MW)
  - **Example question:** For example, how many moles of carbon there is in 5 grams of carbon? (Atomic mass carbon = 12 g/mol). (n=mass/AW)
- **Key concepts:**
  - atomic mass (protons + neutrons, grams per mol);
  - molecular weight (total of individual atomic components) in grams per mole or amu.
  - Simple maths application within chemistry. Essentially chemistry accounting.
- **Structures** are spatial (space, 2D and 3D) representations of molecules (groups of atoms that are bonded together).
- **Example questions: the following questions and discussion prompts draw upon chemistry examples from the dairy food sector.** Invites students to think of the components of the familiar dairy product milk, and different aspects of this industry with economics.
  - what are: a) the molecular masses of each of the following molecules, and b) % by mass for each atomic components (C,H,O) of the overall molecule?
  - <u>Example molecules:</u>
    - **Glucose** ($C_6H_{12}O_6$) – a simple sugar. (MW = 180 grams per mol)
    - **Lactose** ($C_{12}H_{22}O_{11}$)- a disaccharide sugar from 2 sub-units of sugars found in nature (galactose & glucose). This is a key disaccharide sugar found in milk, with some people intolerant to this in their diets. (MW = 342 g/mol)
    - **Casein** ($C_{81}H_{125}N_{22}O_{39}P$) – a major protein found within milk. As a protein, this consists of a long chain of amino acid building blocks that are folded into a larger 3D structure. *It would take a long time for a person to draw the full structure of casein from atom-to-atom structurally, due to the long chains of amino acids and its 3D folded structure!* (MW = 2062 g/mol).
  - **Note: educator can illustrate/ demonstrate the different ways of representing the chemical structures** and/or encourage students to look up this digitally. For example: show each visual representation from the written molecular formula, then 2-dimensional representation, and 3-dimensional structure (e.g., virtually from an online source).
  - **Note that casein as a protein has particular 3-D folding structure** as a protein made up on a long chain of amino acid building blocks.
- **Molecular diagrams & unpacking fundamental molecules:**
  - <u>Simpler molecule examples:</u>
    - **Carbon dioxide** (CO_2) properties – solid, liquid and gas – introduce the structure of CO_2 (linear molecule), its state at room temperature (gas), and importance in our survival (plus uses and impacts: fire extinguishers & climate change too).
    - **H_2O properties** – as a molecule, and as a medium for creating solutions & mixtures.
    - **Glucose** (MW = 180 grams per mol, $C_6H_{12}O_6$)

- <u>More complex molecules:</u>
  - **Proteins** – contrast a simple organic molecule (above example of glucose) with a complex molecule such as a protein,
  - e.g., **casein** (major protein found within milk) – $C_{81}H_{125}N_{22}O_{39}P$ (MW = 2062 g/mol).
  - **Extension examples- problem-solving application:**
    - Question: if milk contains around 3% weight of casein, how much of each element by % would you expect from a 250 gram glass of milk? (*Note: this means 3 per cent share of the total mass, 'weight per weight' (w/w)) – each element C, H, N, O, P*

  - **Agri-food applications**: Prompt students to think of the food system applications and relevance of this chemistry & food technology. For example:
    - **Milk solids** (refers to the dried powder left after all the water is removed from liquid milk, such as milk powder found in supermarkets). This can include protein such as casein, as well as sugars such as lactose.
    - **Milk can be priced according to many factors,** including 'cost per kilogram of milk solids', plus consideration of fat content in the milk. Additional factors that can influence milk prices include:
      - **Economic** (trade, foreign exchange rates, inflation, interest rates, labour market shortages etc.);
      - **Geopolitical environment**: trade access, pricing, relationships with other countries for supplying products.

Chemistry Examples – all with touchpoints to food & materials:

- **Focus:** From simple to complex: the building blocks of food & materials

- Chemistry is all around us & within us. We rely on chemistry (its molecules, ions and reactions) in many diverse ways. This includes the reactions that allow us to produce energy, how we survive through providing nutrition in our diets, our clothing, shelter, technologies and keeping us healthy.
- This section involves: unpacking the main components (molecules) within these substances (stand-alone ingredients, and when combined in a product). Can provide some examples for students – perhaps to do a short summary or inquiry activity.
  - Example: discuss the 'what, where, how' of the molecule, its source & use.
  - Example: Link the molecule from source (industry – e.g., dairy), location (e.g., Tasmania, or Australia more broadly), use (end-product/s) that consumers like yourselves may consume or use commonly.

Chemical components of food:

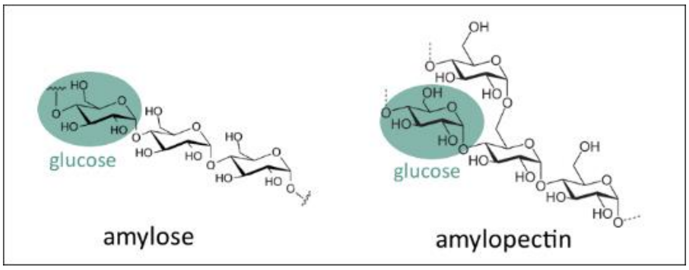
- Example: casein
  - **Food industry link:** Dairy
  - **Who produces this molecule?** Mammal organisms (from platypuses to dairy cows to humans!)
  - **Important for:** growth and development – key source of nutrition for mammals.
  - **Product:** milk (from mammals). Forming various dairy products for consumers.
  - Milk as it comes from the cow contains approximately 87 percent water and 13 percent solids. (i.e., if evaporated the water from 100 grams of milk, there would be around 13 grams of solid material remaining).
  - The solids portion of milk contains approximately 3-4% fat and 9% solids that are not fats (e.g., proteins). Around 4-5g of this solid would be casein protein.
  - **Casein is the main protein found in milk** (however a variety of proteins are found in milk in varying amounts). **It makes up around 80% of the protein within cow's milk (dairy).**
  - **Structure:** casein is produced by mammals and secreted into milk fluid in the form of **colloidal casein micelles** (essentially 3-dimensional largely spherical structures made up of multiple molecules that are held together and organised by **inter-molecular** binding interactions). **There are 4 main types of casein proteins in these sphere structures** (the different types of casein are named depending on their underlying amino acid building block sequence that then fold to form the 3D protein structure). These spheres also contains calcium & phosphorous.
  - Why is the casein molecule found in this structural form?
    - **Casein proteins** have a characteristic of being **hydrophobic (it repels water),** The surface of the sphere that faces outwards and contacts the milk fluid is more **hydrophilic (water-attracting).** However, the actual structure of casein macromolecules is still debated within science!
    - Overall: The casein molecule can exist within the watery milk fluid by pointing its **hydrophobic** casein portions into the centre of the micelle (spherical shaped "macromolecule"). Calcium and phosphorous ions are bound within the structure. Casein is a loosely-folded protein so has some flexibility with conditions of temperature etc.

- Example: Starch
  - **Industry:** cropping & horticulture.
  - **Product:**
    - various carbohydrate-rich foods
    - Non-food products (including for papermaking, bioplastics, adhesives)
  - **Example food types:** potato, tapioca, wheat, corn, and rice (major crops)
  - **Ask & think:** what is it? Where would I find it? Name some crops/ vegetables/ food products that you may find it.
  - **What is the structure of starch?** A complex carbohydrate found in plants, starch consists of two different types of polysaccharides (polymers whose chains consist of sugar units). These polysaccharides are **amylose** and **amylopectin.** The two polysaccharides in starch consist of glucose units that are connected in different ways as a chain.
    - **Amylose** polysaccharide: this this polymer chain is **linear** (connected at the 1 and 5 positions of the 6-member carbon chain glucose).

- **Amylopectin** polysaccharide: this is known as **branched** due to its connection points between the glucose units.

▪ **Think:** space and 3D orientation of molecules are used to describe the structure of molecules in chemistry and nature). See diagram below.

▪ **Note: This can bring different representations of the molecules into discussion**- *including 2-dimensional and 3-dimensional models*. Digital representations (3D versions) can be found online for each molecule.



○ **Example practical or demonstration: Detecting starch in products – including food!**

▪ [Practical demonstration] for a qualitative (observational) test for this – as a guide for the educator, and/or visual demonstration for class see this short video.

▪ **See TIA lesson package** in the [TIA Professional Development Workbook: *Engaging Students in STEM Using Agriculture*] (latest: version 3, 2020) Experiment 7: Laboratory Science: Photosynthesis & Fruit Ripening (page 23).

▪ **Covered in TIA practical:** Photosynthesis introduction (formation of sugars from sunlight, and starch as a storage carbohydrate) & practical using iodide stain to detect starch for fruit ripeness. **Note:** can deliver the whole practical as presented in the workbook, or simply focus upon the practical.

▪ **Starch sources:** corn starch powder dissolved in water is a good stating example in the initial demonstration of the reaction (starch dissolved with result in the blue-black colour change). Could also use cooked/dried pasta, noodles, bread, sliced potato, various fruits (including ripe and unripe), marshmallows (corn starch is a major ingredient). Use directly on the cut/prepared food or potentially need to mash up in water to dissolve the starch.

▪ **Clean water comparison:** Dripping the stain in a sample of clean water to compare will illustrate the difference of the presence and absence of starch.

▪ **Student inquiry:** Students could also conduct their own experiment or trials with items provided or brough into class (e.g., own fruit grown, various food types).

▪ **Practical safety note:** Use the risk assessment guide within the workbook to guide a risk assessment for class. No eating of the food items is to be allowed – iodine stain solution is hazardous for contact and consumption.

▪ **As a class, can discuss the chemistry behind the observed colour change. This could lead into an assessment task including:**
  - A poster or presentation(science communication)
  - A report (student inquiry)
  - Other negotiated forms/media.

- **The science behind the starch test colour changes:**
  - The **polysaccharide amylose** in starch is responsible for the colour change in iodine (changes colour from brown to blue). The amylose chain forms a helix shape (**like the twirl of our DNA's double helix structure).** Iodine can be bound within the helix structure.
  - Additional info: brings together electrons, ions, and complimentary colours: The coloured species observed are caused by so-called **charge transfer (CT) complexes.**
  - **States of iodine and iodide** (neutral and charged ions): Neutrally-charged iodine (I_2) molecules forms polyiodide ions (I_3^-, 1_5^-, or 1_7^- ions – multiple iodine atoms bonding together as a group).
  - **Negatively charged iodide in these polyiodide compounds acts as charge donor**, the **neutral iodine (I_2) as a charge acceptor.**
  - Electrons in these charge-transfer complexes (**I_3^-, 1_5^-, or 1_7^- ions) are easy to excite to a higher energy level by light** (e.g., sunlight, light from lamps). *The light is absorbed in the electron promotion process and its complementary colour is observed by the human eye.*
  - When starch is around (specifically **amylose**): In the case of the water solution of polyiodides (I_3^-, 1_5^-, or 1_7^- ions), the absorptions of the different species lead to an overall brownish colour. **Once amylose is added**, it forms another charge-transfer (CT) complex. Here, the **amylose acts as a charge donor** and the **polyiodide as an acceptor.**
  - This complex absorbs light of a different wavelength than the polyiodide species, and **the solution colour turns dark blue**.
  - Within the assessment task or a formative discussion could discuss:

    - **The industry origins** of various starch-producing crops (& their food items), linking to food production – e.g., bread from wheat grain crops, corn, potatoes.
    - **Geographical location origin** too can be discussed (Tasmania is a key producer).
    - **Implications on society** – including socio-economic dependence on these crops; allergens.
    - **Example resource** article: [Chemistry behind the test.]

- Example: chemical components of wood
  - **Cellulose**- main chemical component is an organic (carbon containing molecule) – the most abundant organic material on Earth. Cellulose is a polymer of repeating 'unit' blocks, which can crystallise to form very strong fibres. Cellulose is the primary strengthening material in wood.
  - **Family of molecules called lignin** – the second most abundant carbon-containing source in earth (first is cellulose), as this is present in plants. **There are several lignin molecules within this family**, and they are united by several properties:
    - **Lignin are complex in structure & natural polymers** (made up of multiple joined units, each containing carbon, hydrogen and oxygen. (Educators could draw parallels to other polymers found in society – including plastics – polyvinyl chloride (PVC), and nylon).
    - Lignin importantly **support the structure** of plants: they enhance plant cell wall rigidity, hydrophobic properties (repels water)
    - Lignin also promotes minerals transport through the vascular bundles in plant to ensure nutrients are moving to where they are needed for development.

Part 2: Mixtures from Agricultural Systems

Compiled for TIA's Professional Learning Workshops *Engaging Students in STEM using Agriculture (2023).*
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Building from the earlier background of atoms, molecules and examples of their structures and properties/characteristics, classes can progress to explore **types of mixtures in nature & society**.

The following content can be delivered & engaged with in several ways. Some examples of this include:

- Content delivered to class by educator (e.g., PowerPoint or hand-out with discussion)
- Divide class into small groups, with each provided a specific mixture to explore. They can be provided with a background pack of content by educator (e.g., based on below information), and/or research this themselves using devices. They could present a short summary of their mixtures to the whole class, including drawing upon links to a specific agricultural systems.
- *See TIA's Science Communication cross-cohort activity task for ideas of peer-peer presentation.*
- Small group or individual inquiry project.

Mixtures: Solutions, Suspensions & Colloids

Background: theory & group discussion opportunity

- **Mixtures:** In chemistry, a mixture is a material made up of two or more different types of chemical substances that are **not chemically bonded to one another**. A mixture is the **physical combination** of two or more substances in which their separate identities are retained.

  Invite class to suggest mixtures that they are familiar with (there are many in everyday life!)

- **Mixtures** are present in the form of **solutions, suspensions, and colloids.** Each of these can be introduced alongside examples and linking back to the class discussion examples where appropriate.

  <u>The following sections include brief introductions & examples of these forms:</u>

- **Solutions:** A solution is a **homogeneous mixture** of **one or more solutes dissolved in a solvent**.
  - **Solvent:** the substance in which a solute dissolves to produce a homogeneous mixture.
  - **Solute:** the substance that dissolves in a solvent to produce a homogeneous mixture.
- **Suspensions:** A suspension is a **heterogeneous mixture** (the components are not uniformly mixed) in which solute-like **particles settle out of a solvent-like phase (layer)** sometime after their initial mixing. Suspensions generally contain larger particle size than seen in colloids (note: colloids continually mix and don't settle out).

- **Colloids:** A **homogenous mixture** (the composition is uniform throughout the mixture) of two or more substances suspended or dispersed in another product/mixture.

  - Colloids are important for society, and particularly our food systems. You consume and interact with colloids every day.
  - You wouldn't be alive if it wasn't for colloids (this includes blood pumping around our bodies!)

    - **A formal definition of a colloid** includes *(you could unpack this to make it more digestible to understand as a class):*
      - A *homogeneous non-crystalline* substance consisting of large molecules or *ultramicroscopic* particles of one substance dispersed through a second

substance. Colloids include gels, sols, and emulsions; the particles do not settle, and cannot be separated out by ordinary filtering or centrifuging like those in a suspension.

- **Phases (different states of matter)** can be solid, liquid or gas.
- **Overall types of colloids:** gels, emulsions, aerosols, foam, sols, solid sols.
- **The table below outlines some examples of each colloid type:**

Table: Examples of Colloid Types			
Dispersed Phase	Dispersion Medium	Type of Colloid	Examples from nature & society
Solid	Solid	Solid sol	Some coloured glasses & gemstones
Solid	Liquid	Sol	Paints
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jelly
Liquid	Liquid	Emulsion	Milk, salad dressing, hair product cream
Liquid	Gas	Aerosol	Fog, mist, clouds, sprays (e.g., pesticides)
Gas	Solid	Solid sol	Pumice stone, foam rubber material
Gas	Liquid	Foam	Froth, whipped cream, soap lather/foam

- **Two components of colloids:** dispersion medium & dispersed phase.

- **Key terms:**
  - **Dispersed phase** (what is dispersed in a bulk dispersion medium)
  - **Dispersion medium** (what the dispersed phase is dissolved in)

Educator can provide examples such as those shown in the table above, or below:

Colloid examples from Agriculture Systems include:

- **Milk**: a colloid containing liquid fat globules (small particles) and proteins dispersed and suspended in water. Phases present: liquid-liquid.
  - **Colloid type: Emulsion**. Option to link to earlier module content – see above (e.g., milk composition is ~87% water, 13% solids).
- Student inquiry or educator-led section: investigate the requirements and definitions of various milk products (such as the IDFA definitions resource), seeing the varying requirements for milk fats and proteins across the various products. Not all products have the same requirements. Ask: why might this be?
- **Industry case study example: the farmgate value of milk in Australia.** Students could explore the Milk Value Portal developed by the Australian Dairy Products Federation (ADPF). You can select a particular region (e.g., Tasmania), and different factors associated with production. The dashboard has annotated comments to assist

interpretation of the dashboard charts/ figures. This is one tool that can be used by the dairy industry to inform knowledge of milk pricing & business operations.

- Butter- the colloid type depends on the temperature of butter: solid or melted! *Butter is a colloid because it disperses as a liquid or fat. Depending on the "dispersion medium" and the "dispersed phase"*
    - Type of colloid:
        - As solid form- butter is a "gel" – gels are colloids containing solid as the dispersion medium and liquid as the dispersed phase (butter, cheese, hair gel are all examples of these). In **gel,** the dispersed phase is liquid, and the dispersion medium is solid.
        - As a liquid (melted butter) – is an "emulsion". In an emulsion, the dispersed phase and dispersion medium are liquid. A colloidal dispersion of a liquid in either a liquid or a solid is known as an emulsion. An **emulsifying agent is required for a stable emulsion**. In a solid emulsion, butter is an example of a liquid in a solid emulsion. Emulsions are very common in food production.
    - Butter components: consisting of water, fats, protein, salt, and some sugars.
    - Option: **link to physical changes** (year 7 Science Curriculum) for butter. **The state of the overall substance at different temperatures** – how these changes with heating and cooling based upon the properties of the substances (mostly fats – long, carbon-containing molecules – show pictures of the structures), loosely held together and weakly bound together as an overall substance).
    - Could include discussion of **salt** – an ionic lattice (rigid, uniformly, neatly packed into a salt crystal formation). Brittle salt; fats are slippery (long, fatty chains).

- **Dairy Industry/ Research Link:** Could connect class with dairy industry representative, TIA's Elliott Dairy Research Facility (North West Tasmania), industry operation (dairy, food manufacturing facility), or a researcher (in-class engagement).

- Sols
    - **Sols: What are they?** A sol is a **colloidal suspension** made from tiny solid particles in a continuous liquid medium.
    - **Examples of sols** include **gel, starch in water, blood**, paint, and pigmented ink.
    - **Sol** – **dispersion medium: liquid, dispersed phase: solid**
    - **Solid sol** – **dispersion medium: solid**, dispersed phase = solid, liquid or gas. Example of a solid sol – pumice stone (dispersion medium = solid rock; dispersed phase = gas (gas particles amongst the rock – pitted holes).
    - **Foam** – dispersion medium = liquid; dispersed phase = gas. Think of lathered soap bubbles in water when washing your hands or hair.
    - **Aerosols** – dispersion medium = gas; dispersed phase = liquid. Think mousse, or canola cooking spray (gas propellant with liquid fat molecules dispersed).

        - **Soil chemistry link**:

        Another example: **Soil colloids** can be defined as the particle of soil with a diameter less than 1µm (1 millionth of a meter!) Soil is composed of a mixture of solids, liquids, and

gases phases. The solid portion of soils comprises an organic material (contains Carbon), and inorganic material.
Soil colloids are the finer size fractions of the soil (clay and organic matter), being also **considered as the most chemically active portion** of the soil because of their large surface area and the chemical structure of the materials involved.

- **Agricultural Science Research or Industry Link:** Guest speakers – an agronomist, soil scientist, geologist, environmental assessor, or related researcher (in-class engagement, or field visit).

Inquiry Activity: Mixtures in Environments

Aims: Students will identify the different types of solutions, suspensions and colloids that are present in different environments, explaining their components and interactions. Drawing together examples from each of the above content areas. Awareness of the presence of different chemical mixtures across an environment & their importance for nature & society, such as agricultural food production.

- **Task:** Students are to identify the 3 main types of mixtures in a selected setting or environment. State the environment/setting, and why they have chosen this (e.g., personal interest, link to their location).
  - All mixture types are to be included (solutions, suspensions, colloids), and multiple examples.
  - For colloids, students are to identify what dispersion phase and dispersion medium are present.
  - Could also draw upon specific molecules discussed in the atoms & molecules section (Section 1).

- **Option:** Peer sharing/ presenting work following the task can be a good science communication opportunity within or across classes *(peer-to-peer science communication – also see TIA resource).*

Format: This activity could be an inquiry-based individual task, or within a small group.
- **Graphical organisers** can work well for this exercise (e.g., general templates, or specifically develop for the task).
- **Include:** Visual and/or written identification & communication of key concepts. (e.g., diagram, written in workbook, paper poster, PowerPoint, or another format). Illustrate and identify the types and explain the connections present.
- **Other example formats**: create a 'colloid collage', 'suspension/ solution scrapbook'.

Assessment: Option for non-assessment, or adopt the following:
- Summative or formative assessment options (discussion, portfolio activity, peer-reviewed activity, or reflection).

Example of Environment- Cross-section of a mixed enterprise agricultural setting:

- Plants (e.g., cross-section of a plant stem showing flowing water with **solutes (solution)**; water with **ions (solutes)** travelling through the plant roots.
- Sap from leaves dripping (solution of solutes: glucose, salt ions etc.).
- **Soil colloids** (inorganic and organic).
- Dairy cows –producing **milk** (colloid: emulsion).
- Within the dairy cow – blood and cells within the body system (colloid: sol).
- Spray on the crop/pasture- e.g., fertiliser, insecticide, fungicide. (Colloid: aerosol).
- Clouds (colloid: aerosol, gas with fine crystals of ice, solid).
- **Suspension** of muddy water in the puddles and water troughs.

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