2024 Stage 6 Consultation – Biology: Science Teachers' Association of NSW Response
https://www.nsw.gov.au/education-and-training/nesa/news/syllabus-consultations

1. What are the strengths of the draft syllabuses?	○ We like the detail for the modules, but it is too content heavy ○ Aboriginal and Tores Straight Islander content is excellent, however more guidance is needed in this area ○ There is a lot of modelling in the syllabus (positive), however it takes a lot of time to get through ○ We like the Three modules in Yr11, however they need fewer indicative hours ○ Genetics module is still rigorous ○ Having biodiversity back in yr 12 allows for breadth of subject ○ Positive response to Biotech ○ Sectioned areas flow well ○ Positive response to Field Studies
2. Are there any content points requiring further refinement?	**Yr 11** **Cells** ○ Wet mount slide of a plant – give examples of plants ○ Variety of specialised cells – be more specific ○ Need to provide examples regarding cell structures and BioChem processes ○ Merge the outcomes "conduct a practical investigation to explain the effect of temperature, pH and substrate" with "analyse data and information on the effect of temperature, ph". This needs to include "to collect data" after "conduct a practical investigation" ○ What is the difference between representations and models? Please clarify ○ Please clarify/simplify "solve problems relating DNA replication, mitosis and meiosis". These are complex and could lead to tangents and distractions. You will need specific examples here. **Cells To Systems**

	• "Compare the organisation of cells in unicellular and multicellular organisms"
	  ○ This table will be limited if we are looking for characteristics of how a single cell is organised in relation to itself. Perhaps you are looking to "Compare the characteristics and structure of unicellular and multicellular organisms."
	
	• "Conduct a laboratory experiment to predict and explain the effect of the surface-area-to-volume ratio on the rate of movement of materials into and out of a cell."
	  ○ If we are being explicit – we need an outcome that first teaches SA:V ratio...then conduct an experiment "predict and explain".
	
	• "Justify the hierarchical organisation of organelles, cells, tissues, organs and systems in organisms"
	  ○ This verb may be incorrect – perhaps use "describe"?
	
	• "Compare nutrient and gas requirements of autotrophic and heterotrophic organisms"
	  ○ This belongs in the next section, after teaching respiratory and circulatory systems (open/closed). If not, we run the risk of missing a large component of entomology which appears in year 12 biodiversity.
	
	Plants as autotrophic organisms
	
	This unit requires updates.
	
	• "Use dissected plant material and observations of microscopic leaf structures to relate the structure of the cuticle, epidermis, palisade mesophyll, spongy mesophyll, stomata, guard cells and vascular bundle of xylem and phloem to their functions."
	  ○ This is clunky.
	  ○ Relate the structure and function of leaf and stem of vascular plants.
	  ○ Investigate leaf anatomy using plant materials or microscopic resources.
	
	• "Plan and conduct a practical investigation to demonstrate the conditions required for photosynthesis"
	  ○ Are we trying to be explicit? Perhaps state "Describe photosynthesis".

	• "Conduct a secondary-source investigation on how plant structures facilitate gas exchange"
	  ○ Why does this need to be a secondary source investigation? It feels limiting, suggest change to 'Explore' or just 'Investigate' so that the context can chose how to proceed.
	
	• "Use dissected plant material and observations of microscopic stem structures to relate the structure of the pith, cambium, cortex and vascular bundle of xylem and phloem to their functions"
	  ○ See above – are we trying to be explicit?
	
	• Compare the structures and functions of the tracheid, pit, sieve tubes, sieve plates and companion cells within the plant transport system
	  ○ Move this above when focusing on Xylem and Phloem.
	
	• "Conduct a secondary-source investigation to evaluate theories of the movement of materials through xylem and phloem tissue. Cohesion-tension theory, translocation theory."
	  ○ Do you mean like this? How Trees Bend the Laws of Physics If we do this – do we go into activation energy? Recommend taking out the specification for a "conduct a secondary source".
	
	• "Explain how light, temperature, wind and humidity affect the rate of transpiration in plants."
	  ○ This could come before the outcome 'Explore how plant structures facilitate gas exchange'
	
	• "Explain how osmotic pressure, transpiration stream, and cohesion of water molecules control the movement of water and dissolved minerals through the xylem."
	  ○ Pedagogically - we have asked students to "conduct an investigation" and then after this we teach them. This is reminiscent of PBL and exploratory learning. We need to rethink how and why we would ask them to explore theories and then teach them what happens.

	• "Use dissected plant material and observations of microscopic root structures to relate the structure of the root cap, root hairs, meristem, endodermis, parenchyma cells, cortex and vascular bundle of xylem and phloem to their functions."
	  ○ Simplify.
	
	• "Explain the use of carbon-14 to trace the movement of the products of photosynthesis"
	  ○ Add to the photosynthesis section.
	
	• "Relate system structures and functions to the requirements of a plant"
	  ○ This outcome is redundant as the specific systems have been unpacked already. For example: vascular bundles, leaf structure, xylem and phloem. What is missing are the words "transpiration" and "translocation".
	• **Cells organisation**
	  ○ Clarify the difference between "conduct a laboratory experiment" with "conduct a practical investigation".
	
	Animals
	
	• "Account for the structure and function of plasma, red blood cells, white blood cells and platelets within blood."
	• "Use models of arteries, capillaries and veins to correlate their structure with function."
	• "Account for changes in the composition of blood as it travels through the lungs, liver, digestive system, kidneys and other tissues."
	  ○ This seems out of order - Start with vascular bundles, as you did in plants. Then go to the cellular level. Then go to the composition.
	
	• "Interpret graphs of the oxygen-haemoglobin dissociation curve to explain the adaptive advantage of haemoglobin."
	  ○ Great opportunity for data analysis here.
	
	• "Use representations to demonstrate how alveoli and capillaries allow for efficient nutrient exchange."
	  ○ This goes before changes in composition of blood.

	• "Use models to explain the structure of the glomerulus, Bowman's capsule, proximal tubules, distal tubules, loop of Henle, and collecting tubule within the nephron, and their roles in the production of urine."
	  ○ We need to teach what the Kidney does first.
	
	• "Explain how glomerular filtration and selective reabsorption and secretion across nephron membranes contribute to the removal of waste
	  ○ This is basically the previous outcome if it had the word 'function' in it. Outline the structure and function of the kidney and its role in the removal of waste.
	
	• "Conduct a secondary-source investigation to compare the process of renal dialysis to the function of the kidney."
	  ○ This is fine – we got to this via disease of the organs last time. Do we need to look at disease of the other systems we are looking at?
	
	• "Relate system structures and functions to the requirements of an animal."
	  ○ This is too broad and unclear. Teachers will need to know what they are teaching. Is it open/circulatory systems? Which systems? Maybe this section could be broken into three systems? Circulatory, respiratory and excretory?
	
	Homeostasis in humans
	• "Analyse information from secondary sources to account for observed symptoms of hyperthermia and hypothermia."
	  ○ "Account for observed symptoms" can happen without secondary resources – could we move that to something else?
	• "Outline the difference between tolerance zones and tolerance limits"
	  ○ Perhaps "determine" rather than "outline".
	• "Relate motor neurons, sensory neurons and interneurons to their structural and functional characteristics."
	• "Conduct a scientific investigation to model a nerve impulse in terms of transmission of an action potential and synaptic transmission, referring to neurotransmitters, receptors, synaptic cleft, vesicles, postsynaptic and presynaptic neurons, and signal transduction."
	• "Analyse the impact of diabetes and metabolic disorders on the body's ability to maintain homeostasis and disrupt negative feedback mechanisms."

	• "Relate the internal coordination of systems in humans to maintain their internal environment"
	  ○ Keep the nervous content together, then move to the endocrine.
	
	Evolution
	• "Discuss how genetic variation, inheritance and selective pressures in evolution due to natural selection"
	  ○ Add an outcome with the definition/description of the natural selection process.
	  ○ Relate the outcome of Aboriginal cold burn to the effect of evolution.
	  ○ Analyse information on stomatal control and crassulacean acid metabolism (CAM) as mechanisms used by C3 and C4 plants to regulate water balance and prevent excessive water loss.
	  ○ Hydrophyte, xerophyte and mesophytes from previous syllabus. C3, CAM and C4 is new content – provide some examples for each.
	
	Ecosystems
	• "Conduct a practical investigation to examine the distribution and abundance of a plant using belt transect and quadrat sampling techniques"
	• "Use quadrat data to estimate abundance"
	• "Describe the mark-release-recapture method and estimate abundance of mobile organisms"
	  ○ Any one of these can be conduct an experiment or investigation. Ecosystem relationships – conduct fieldwork - give examples for all situations
	
	Yr 12
	<u>Heredity</u>
	Inheritance patterns
	• "Diagrams of haemoglobin"
	  ○ (For what reasons) be specific – is this in relation to protein structure?
	• "Conduct a practical investigation to demonstrate the effect of environment on phenotype"
	  ○ Great – how are we doing this? Are we growing things?

	• "Interpret recombination frequency data to create linkage maps to determine the proximity of genes on a chromosome"
	  o Need resources/examples for any new statistical data required ie recombination frequency. A data book could be really helpful here.
	• "Conduct a practical investigation to model the crossing over of homologous chromosomes during meiosis to compare the impact on the inheritance of linked and unlinked genes"
	  o How is this a practical? Could be specific and keep "Model".
	
	Genetic variants
	• "Analyse the implications of somatic and germ line variants in the context of genetic diversity, disease development and genetic inheritance"
	  o This should be the second outcome.
	
	<u>Disease</u>
	Epidemiological studies
	
	Most people want to do this well, a data book would be helpful here. There are some residual case study materials in relation to smoking and lung cancer, but it is old. It could include resources of epidemiological studies to evaluate.
	
	• "Explain how epidemiological information is used to create strategies that prevent and treat diseases in plants and animals"
	  o Perhaps separate as plants and animals are very different and could pull or push into quarantine. Also provide examples.
	• "Compare scientific causation and correlation using herpes, human papillomavirus (HPV) and cervical cancer data"
	  o This is helpful as it provides some guidance with an example. We could we do this with the next outcome as well.
	
	• "Discuss selection error, information bias, measurement bias and confounding factors in a variety of epidemiological studies"
	  o Mention error and confirmation bias for the epidemiological studies, need examples here.
	  o Infectious diseases need a better sequence of outcomes to build up knowledge.

	Non-Infectious Disease
	• "Analyse worldwide data of the incidence, prevalence, morbidity and mortality rates of cardiovascular disease, to compare gender and ethnic group risk factors"
	  o This could use some suggested references to align. It's a huge dataset to get lost in so some boundaries would be helpful.
	• "Explain the potential benefits of using native grasses as part of Aboriginal Cultural Practices to reduce nutritional disease"
	  o Great to reference two – will there be some supported resources to help teachers here to use appropriate sources of knowledge?
	• "Evaluate the method of an epidemiological study of smoking and lung cancer"
	• "Justify how causation was proved between smoking and lung cancer"
	  o Put this in epidemiology
	• "Evaluate, using examples, the benefits of engaging in an epidemiological study"
	  o This stays in epidemiology
	
	Infectious Disease
	• "Describe adherence factors, invasion factors, capsules, toxins and lifecycle changes in relation to specific pathogens"
	  o This is a lot of content.
	• "Conduct a practical investigation to demonstrate how the innate and acquired components of the immune system respond after primary exposure"
	  o Is "conduct" appropriate? Are we using lab mice or humans?
	• "Use data to demonstrate how vaccinations support acquired immunity"
	  o Data book or identify specific sources of information for this, we need to guide carefully here. Would be good to use the old outcome in relation to types of vaccines first, also considering the huge scientific advances in vaccines with the latest pandemic.
	• "Compare antibiotic and antiviral use on pathogens"
	  o Is this the place for immunotherapy? It's another big advance and we should attempt to be contemporary.
	• "Conduct a secondary-source investigation to evaluate the effectiveness of different strategies in controlling the spread of disease in a plant or animal"
	  o There is an opportunity to either break up plant and animal or move the plant back into plant section.

	• "Design an epidemiological study into the breakout of an unknown disease, include sample size, duration, composition of cohort, prevention of bias and methods of analysis to propose causation and recommendations for public health strategies"
	  o Why is this here? It can move back to epidemiology.
	• "Relate pathogens to the causes, effects and management of infectious diseases"
	  o This can move up to the top of this section. It's alone and disjointed in this section.
	
	<u>Biodiversity</u>
	Changing ecosystems
	• "Evaluate the validity of scientific evidence to support hypotheses on the extinction of Australian megafauna"
	  o Resource suggestion would be helpful after contested Dark Emu.
	
	Monitoring ecosystems
	• "Conduct a practical investigation to collect and analyse data to assess the effects of invasive species on the local environment"
	  o Is this illegal? Not sure we should be conducting here, could use a second-hand resource.
	• "Analyse the natural and human-induced causes for Australian species becoming threatened, endangered or extinct, and the consequences of this"
	  o Analyse the natural and human-induced causes and consequences for Australian species becoming threatened, endangered or extinct
	• "Analyse population growth data to determine the mode of population growth as exponential growth (J-curve) or logistic growth (S-curve)"
	  o This is a new skill in year 12 science. The standard/advanced math equivalent should be referenced.
	
	Sustainable ecosystems in the future
	• "Sustainable ecosystems in the future"
	  o This is a great opportunity to learn about cultural practices but we need more guidance here.
	
	<u>Biotechnology</u>
	Biotechnology in agriculture and biodiversity

	• "Compare the process and outcome of a current cloning technique and a current reproductive technology using animals in Australian agriculture"
	  ○ Break this up. Identify agriculture as a focus, then look at artificial pollination, then cloning, then application in agriculture.
	• "Evaluate the environmental impacts of transgenic organisms on agricultural crops"
	  ○ Again – break this all up into areas so students can follow a thread that makes sense to them.
	  ○ There are a few dot points that could have some examples given as have been done for other dot points.
	
	Biotechnology in non-infectious diseases
	• "Account for the use of 2 current biotechnologies in the precise diagnosis of non-infectious diseases"
	  ○ We need to be prescriptive here rather than asking for 2 random biotechnologies.
	• "Explain the processes of 2 current biotechnologies in the management of a named non-infectious disease"
	  ○ We should bring these together. "Describe current biotechnologies including but not limited to (1 & 2) and explain their use in the management of non-infectious disease".
	• "Conduct a practical investigation to model the process of recombinant DNA technology to produce human insulin"
	  ○ Only a limited number of schools have access to this technology, and it is expensive.
	  ○ Is co-funding the AMGEN program available for all schools?
	  ○ "Research", "explain", "describe" or "model" more appropriate than "conduct" here.
	Biotechnology in infectious diseases
	• "Compare the process of 2 current biotechnologies used in disease diagnostics"
	  ○ Suggestion: Use the words "Including but not limited to".
	• "Explain the application of a current biotechnology and model how the process is used to diagnose and prevent a named infectious disease of a plant"
	  ○ Provide examples here.

3. Are scientific investigations sufficiently flexible for implementation by teachers?	○ Information needs to be given for various school environments. Metropolitan and Regional schools have different facilities, for example there is not always a lab technician, or teachers may be teaching out of expertise area. ○ The language around "conduct" and "investigate" needs to be clear. Do not use the word "conduct" if you are after a model. Simply say "model". Here is an example from the draft: "Conduct a practical investigation to model the process" changes to "Model the process of..."
4. Do the syllabuses provide flexibility for teachers to support diverse learners?	○ This is a lot of content for diverse students integrated into the classroom. ○ The Life skills syllabus is a lot more open for teachers in that area to be flexible as to what and how to teach for those diverse students. ○ Not indicating the working scientifically skills focus on each focus area may lead to teachers not even considering them in their teaching and focus on the content statement only. ○ Content statements need to consider the depth and angle of approach to the outcome. Currently it is misaligned with the need in the outcome. For example - *'Predict the effects of hypertonic, hypotonic and isotonic solutions on animal and plant cells'.* We cannot predict without first knowing the content – this is from the NESA pedagogical focus, otherwise we are landing in the space of exploratory learning. It happens in quite a few places in this draft and needs serious consideration. The more clarity, the easier it is to teach diverse learners.

General Comments:

- Working Scientifically in Stage 6 needs to work with the new 7-10 syllabus. The continuum of skills does not currently work.
- A databook is needed for Stage 6.
- Assessment: Is the move towards minimum of one exam new? Is there a rationale?
- While it is good to be moving to 3 modules in year 11, the 120 hours teaching requirement in Year 11 is not feasible.
- A glossary of terms is needed, with correct definitions.
- Numbers (and letters) are needed to number all the headings and sections and outcomes, so that teachers all know which we are referring to.
- Depth study and field work included in 2017 Syllabus but no field work in 2024 draft – Why is this?
- Consistent language is needed across the syllabus for all terminology. For "Representations" and "models" - what is the difference? Also "Investigation" and "demonstration" isn't well delineated. This will be particularly important for early career teachers.
- Schools in Rural and Remote areas might struggle with this syllabus if they do not have adequate resources
- NESA guidance for Aboriginal & Torres Strait Islander perspectives is crucial.

- The balance between using practicals to demonstrate a concept versus having student do authentic scientific investigation isn't there.
- Explicit permission structure for investigations needed.
- A progression of understanding in each discipline from stage 4-6 would help to guide teachers in their understanding.

Biology Specific content

- The syllabus is very content heavy. There has been an increase in material that has not been covered in the past.

Across all syllabuses:

- 7-10 new working scientifically outcome should be aligned better.
- Numbering of the outcomes.
- Is the syllabus appropriate for schools with limited resources and low SES?
- Difficulty getting 120 hours into 3 terms for Yr 11 when Yr 12 have 4 terms to do 120 hours?
- Could we have NESA guidance as to who to contact over the state regions to help with Aboriginal and Torres Strait Islander science and culture? Or does NESA have a consultant we can contact?
- One of the things about practical investigations skills, modelling skills and Working Scientifically skills is that it takes time to develop them in students. We all need to practise skills so that we can master them which takes time.
- Creating a support document (as per junior syllabus) would be beneficial. This should indicate background knowledge needed from juniors in each focus area and examples of practical investigations and depth studies and link to datasets.
- Clear definition of verbs and a clear glossary for metalanguage and working scientifically terms is needed. is needed. For example, what is the difference between a "model" and a "representation"?
- Organise the content outcomes (dot points) into sub-sections with a logical flow and sequence of building up knowledge. This will help new teachers to the subject.
- Separate the content into animals and plants sub-sections in some of the modules.
- Needs consistent language across the syllabus for all terminology.
- We feel there is a need for new teachers to have a guide of how to integrate Working Scientifically into topic areas.
- Assessment – new rulings for assessment including topic tests and exams.