ASELL for Schools Workshop

Laboratory Learning Activity Manual

Mooroolbark College

27 October 2017

CONTENTS

ACKNOWLEDGEMENTS

We would like to thank:

WELCOME

Welcome to an ASELL for Schools Workshop!

ASELL (Advancing Science and Engineering through Laboratory Learning) has developed over the last 10 years. This project developed from its physical chemistry APCELL predecessor and then expanded to incorporate all of chemistry (ACELL). After successful trials of using ASELL principles at workshops in physics and biology, the project has now expanded to include biology and physics, and more recently engineering, hence the name change.

The ASELL project has been designed to help address challenges in student learning which arise in science laboratories. By bringing together diverse expertise and resources, it is possible to develop a collection of experiments, which can facilitate student learning, whilst also taking into account variations in student differences. In 2010, the first national ASELL Science Workshop was held at the University of Adelaide.

This ASELL for Schools workshop is the second Victorian workshop to be run under the Australian Mathematics and Science Partnership Funding Grant, which was awarded to ASELL in 2014. This phase of the project has been initiated by Deakin University in conjunction with the University of Sydney with support from ReMSTEP and the Australian Council of Deans of Science. With the introduction of the new Australian and Victorian Curricula now in place, an opportunity exists to address current school-based experimentation and incorporate science inquiry. ASELL for Schools will provide the following three outcomes:

- A repository of experiments with all associated documentation necessary to run them, ranging from health and safety notes, necessary equipment and resources, notes for technical staff to the science learning objectives and how the experiment achieves them.
- Authentic professional learning workshops on experimentation in schools.
- An interface and interaction between school and university staff.

Today, you will be participating in laboratory activities and discussion sessions to expand your understanding of issues surrounding learning in the laboratory environment. In particular, it is important to be able to experience the experiments as learners.

In addition to the formal program, please take the opportunity to exchange ideas about science and education and get to know each other, as an additional aim of the ASELL for Schools project is to build a community of educators interested in laboratory-based education and other aspects of science education.

We would like to gratefully acknowledge the efforts of the submitters in presenting their experiments, as well as the assistance of technical staff and others in making this workshop possible. A very big thank you to the team at Mooroolbark College, for hosting this Workshop. Each person has put in a lot of hard work to get this workshop set up and running. I want to thank everyone!

If you have any questions about the project, please speak with me or one of the Victorian ASELL for Schools team, who are present.

Sincerely,

Kieran Lim

Kieran Lim
ASELL for Schools Victorian Leader, on behalf of the ASELL for Schools Team

ASELL FOR SCHOOLS WORKSHOP SCHEDULE

	ASELL for Schools **Mooroolbark College** ***Friday 27 October 2017***	
9:00 – 9:15	**Arrival/Registration**	
9:15 – 9:30	**Welcome and Introduction** with A/Prof. Kieran Lim • Introductions (of ASELL for School team and Students and Teachers) • Outline ASELL for Schools • ASELL for schools – host workshop as a Teaching Scholar • Longitudinal research – over the next three times	
9.30 – 10:00	***Laboratory Learning Activity 1 – "Honeycomb Structures"*** ***Part A*** ***Making the Honeycomb Structures*** with A/Prof Kieran Lim	
10.00 – 11.00	**Teachers: Inquiry Skills in Science** with Dr Peta White • How can we incorporate more science inquiry and inquiry skills into science? • Introduction to the inquiry scaffold tool	**Students: Making more honeycomb structures** with Dr John Long and Mr Ian Bentley
11:0 – 11:20	**Morning Tea**	
11:20 – 12:20	***Laboratory Learning Activity 2 – "Cancer"*** with Dr Peta White and Amanda Peters	
12: 20 – 12: 40	Discussion and feedback on Laboratory Learning Activity	
12:40 – 1: 10	**Lunch**	
1.10 – 2:10	***Laboratory Learning Activity 1 – "Honeycomb Structures"*** ***Part B*** ***Testing the Honeycomb Structures*** with A/Prof Kieran Lim, Dr John Long and Mr Ian Bentley	
2:10 – 2:30	Discussion and feedback on Laboratory learning activity	
2:30 – 3:00	Overall debrief and Evaluation for the day with A/Prof Kieran Lim and Dr Peta White	

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ASELL SCHOOLS
Advancing Science & Engineering through Laboratory Learning

LABORATORY LEARNING ACTIVITY 1 - HONEYCOMB STRUCTURES

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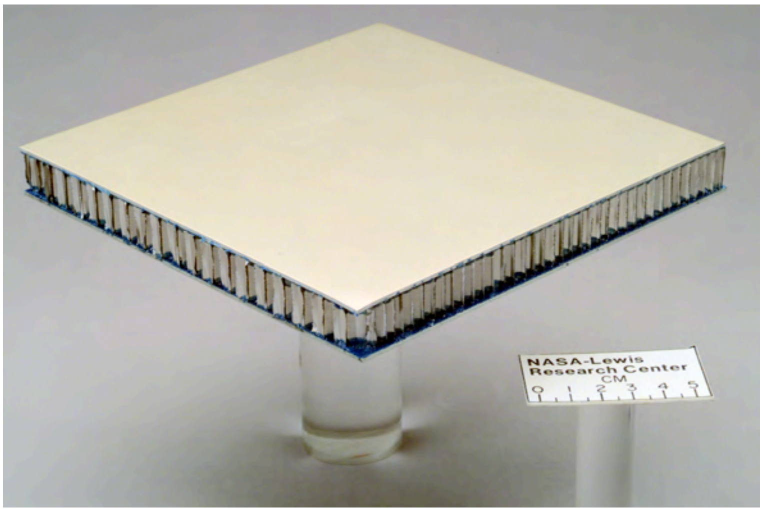
ASELL SCHOOLS Advancing Science & Engineering through Laboratory Learning
Australian Council of Deans of Science
ReMSTEP
Australian Government Department of Education and Training Office for Learning and Teaching
DEAKIN UNIVERSITY

Honeycomb Structures

Introduction

A common aim of materials scientists and engineers is to create materials with the greatest strength and the minimum weight and minimum amount of materials (minimum cost). Honeycomb sandwich structures are often used to achieve these outcomes and are used in aerospace, automotive, housing, packaging, sports-equipment and other industries. These structures have an arrangement of tubes (or channels) sandwiched between two walls.



Glass aluminum reinforced (GLARE) honeycomb composite sandwich structure.
Photograph has been used and redistributed under an educational non-commercial licence by permission of NASA.
<https://commons.wikimedia.org/wiki/File:Glare_honeycomb.jpg>

Cardboard is often made by sandwiching a sheet of corrugated cardboard between two sheets of thick paper. In corrugated cardboard, the open sections run **parallel** to the walls.

Forces applied at right angles to the honeycomb channels will cause the structure to deform.

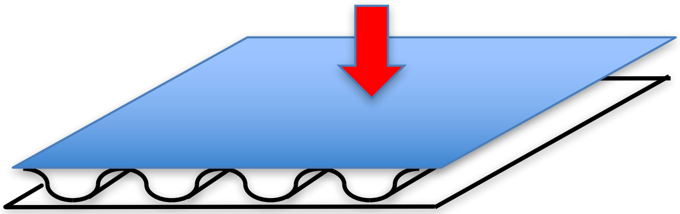
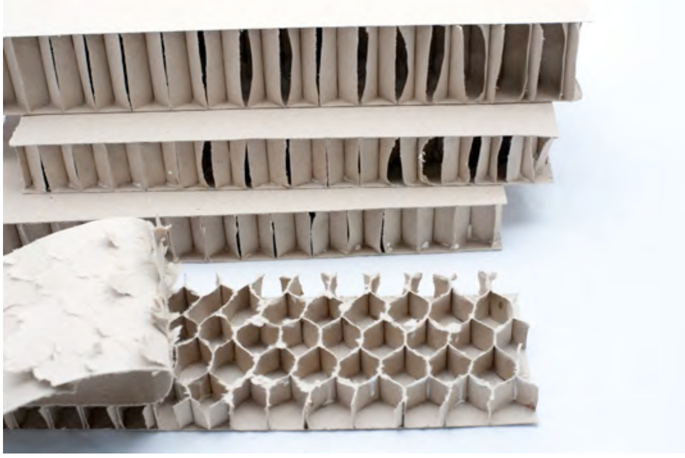


Diagram of corrugated cardboard.
Diagram by Kieran F Lim.

In some other structures the open tubes are arranged at **right angles** to the walls. These tubes can be different shapes in cross section. They could be circles, squares, triangles or hexagons (like honeycomb).



Honeycomb pattern for strength in cardboard. Image by sciencestockphotos.com. <http://sciencestockphotos.com/free/engineering/slides/cardboard_strength.html>

Key ideas

Force - A force is a push or a pull. A force can cause movement in an object or cause compression, tension or torsion within the object.

Impact - Impact or impact force is a shock or large force applied for a very short time.

Compression force – a push that squeezes an object to try to make it smaller or shorter.

Tension force – a pull stretches an object to try to make it bigger or longer.

Strength – The ability of a material to resist breaking when a force is applied.

Strength to mass ratio - This is a measure of the strength of a material compared to its mass.

Investigation - A scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities

Variable - Something that can change.

Dependent variable - Variable that changes in response to changes in the independent variable and that is observed or measured.

Independent variable - Variable that is deliberately changed.

Controlled variables - Variables that are kept constant.

Fair test - When testing different materials all the variables except the one being tested need to be kept the same.

Equipment and materials

- Paper, cardboard, straws
- Scissors
- Craft knives
- Glue
- Rulers
- Pencils
- Weights, bricks

Investigation

In this activity, your task is to investigate a question of your own about the strength of honeycomb structures and then you will formulate a hypothesis based on scientific knowledge. Once you have your question you need to design a way to answer it by constructing the different honeycomb structures out of paper, cardboard and glue and testing their strength. You will ensure that your tests will be fair and provide data relevant to answering your question. You will collect, analyse and evaluate the data communicating your findings appropriately.

Hazards

Cutting materials with scissors or blades poses the risk of cuts. Care should be taken to keep hands and fingers out of the way. Always cut way from yourself. Make sure sharp objects are stored safely when they are not being used.

Testing the sandwich materials with loads has potential for injury. Care must be taken. Ensure all people are at a safe distance.

Scientific questions

Suggest one or two scientific questions that you could ask using your experimental equipment and materials:

Some scientific questions will be more suitable for investigation in a classroom setting. Your teacher will lead a discussion to decide which scientific questions will be investigated. Your group will then decide how to investigate that question.

The scientific question that my group will investigate is:

A hypothesis is a testable "educated-guess" answer to a scientific question. A hypothesis leads to one or more predictions that can be tested by an investigation.

Our hypothesis is:

Remember to think about variables that will need to be controlled to ensure a "fair test". Decide which variables you will keep the same (controlled variables) which variable you will change (independent variable) and which variable you will measure (dependent variable).

Our **independent variable** is:

Our **dependent variable** is:

Our **controlled variables** are:

We will use the following **experimental procedure**. (If appropriate, make a drawing of your proposal.)

Are there any **safety** issues to consider?

Testing our scientific question

What happened? Record your observations or measurements.
Remember to include units for all numerical measurements.

Analysis of results

Do you need to summarize your results, draw graphs or do calculations such as work out averages? If so show your analysis here.

Discussion and Conclusion

Write a discussion of your inquiry noting your conclusions and reasons. Indicate the strengths and weaknesses of your procedure and how confident you are in your results. Identifying impacts and limitations of conclusions using appropriate scientific language and representations.

Extension

Use an internet or library search to find applications of honeycomb structures.

Scientific poster

1. Complete introduction:
   - One- to two-paragraph overview of the reason for completing the investigation, the scientific context and an explanation of the relevant scientific theory.
   - All sources need to be acknowledged.

2. Complete the discussion section:
   - Discuss your scientific question in this section. **POE** is often a useful guide is to help what you put in this section:

   a. Predict. Your scientific question, hypothesis and prediction of what will happen.
   b. Observe. What you observed or measured.
   c. Explain. Did your observations or measurements agree with your expectations and prediction? Can you explain why?
- Discuss the implications of your results.
- Were there any limitations to your investigation?

3. Complete the conclusion section:
   - State your main result from your investigation.
   - State whether this supports or refutes your hypothesis.

4. Complete References and Acknowledgements.

Acknowledgements

The contributions of members of Scouts Victoria to the refinement of this laboratory learning activity are gratefully acknowledged.

- Photograph of a honeycomb pattern for strength in cardboard has been used and redistributed under a Creative Commons (CC BY 4.0) licence <sciencestockphotos.com/imagelicense.html>.
- Photograph of Glass Aluminum Reinforced (GLARE) honeycomb composite sandwich structure has been used and redistributed under an educational non-commercial licence by permission of NASA <https://www.nasa.gov/multimedia/guidelines/index.html>.

LABORATORY LEARNING ACTIVITY 2 – UNDERSTANDING CANCER

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ASELL SCHOOLS Advancing Science & Engineering through Laboratory Learning LABORATORY LEARNING ACTIVITY

Understanding Cancer: How does cancer start and spread?

Introduction

Cancer is a disease of the cells, which are the basic building blocks of the body. The body is made up of trillions of cells. These cells normally grow and divide to replace old or damaged cells as the body needs them. Sometimes this process does not occur and cells grow, divide and die abnormally. Old cells and damaged cells may survive beyond their life cycle while new cells may form when not needed. This may cause blood or lymph fluid in the body to become abnormal, or form a growth called a tumour. Essentially cancer cells are doing a normal process but at an inappropriate stage of the life of a person.

A tumour can be benign (restricted to one area and not able to be spread) or malignant (made of cancerous cells and able to spread or invade nearby tissue). Often when malignant tumours arise some of the cancer cells are able to break away from the tumour and travel by either the circulatory or lymphatic system to tissues far away, forming new tumours in these areas. The body regulates itself to ensure a stable state this is known as homeostasis. Cancer in this case skin cancer is an imbalance of homeostasis.

- http://www.cancervic.org.au/about-cancer/what-is-cancer
- https://www.cancer.gov/about-cancer/understanding/what-is-cancer

A Deakin University scientist (Professor Leigh Ackland), a teacher (Mary Vamvakas) and a pre-service teacher (Esme Wright), and Deakin University Education academic (Peta White) worked in a workshop situation to develop the following activity. This work is based on Leigh's current research. Please find links to Leighs profile page at Deakin University to find out more about her and her research and we have also recorded a video to support the understandings of her research and her passion for science.

Professor Leigh Ackland, School of Life and Environment Sciences, Deakin University

- Website: http://www.deakin.edu.au/about-deakin/people/leigh-ackland
- Video Link: https://video.deakin.edu.au/media/t/0_vbzakdi5

Curriculum Outcomes - Victorian Curriculum - level 9 and 10

Explaining phenomena involving science and its applications. Students consider both classic and contemporary science contexts to explain the operation of systems at a range of scales. They learn that matter can be rearranged through chemical change and that these changes play an important role in many systems. At a macroscopic scale, they explore ways in which the human body as a system responds to its external environment, and investigate the interdependencies between biotic and abiotic components of ecosystems.

Key ideas [Footnote [1]]

Cell - A basic unit of living matter separated from its environment by a plasma membrane; the fundamental structural unit of life.

Cell membrane – The outer membrane of the cell; the plasma membrane.

Nucleus – An atom's central core, containing protons and neutrons. (2) The chromosome-containing organelle of a eukaryotic cell. (3) A cluster of neurons.

Extracellular matrix – The substance in which animal tissue cells are embedded; consists of protein and polysaccharides.

[1] Definitions from Glossary of Biological Terms: The Biology Place – Pearson. Retrieved from <http://www.phschool.com/science/biology_place/glossary/t.html>

Basement membrane – The floor of an epithelial membrane on which the basal cells rest.

Immune response – A highly specific defensive reaction of the body to invasion by a foreign substance or organism; consists of a primary response in which the invader is recognized as foreign, or "not-self," and eliminated and a secondary response to subsequent attacks by the same invader. Mediated by two types of lymphocytes B cells, which mature in the bone marrow and are responsible for antibody production, and T cells, which mature in the thymus and are responsible for cell-mediated immunity.

Enzymes – A class of proteins serving as catalysts, chemical agents that change the rate of a reaction without being consumed by the reaction.

Tissue – An integrated group of cells with a common structure and function.

Task 1: Comparing Normal Cells to Cancerous Cells

Go to the following link:
http://www.mhhe.com/biosci/genbio/virtual_labs/BL_23/BL_23.html

Use the simulation program "Virtual Lab Cell Reproduction: How can cancer cells be recognised?" that enables the comparison normal to cancerous cells. Select similarities and differences between cells.

Follow the procedure in the virtual lab and fill in your data and answer the questions below.

	Inter-phase	Pro-phase	Meta-phase	Ana-phase	Telo-phase	Percentage of cells dividing	Percentage of cells at rest
Normal lung							
Cancerous lung							
Normal stomach							
Cancerous stomach							
Normal ovary							
Cancerous ovary							

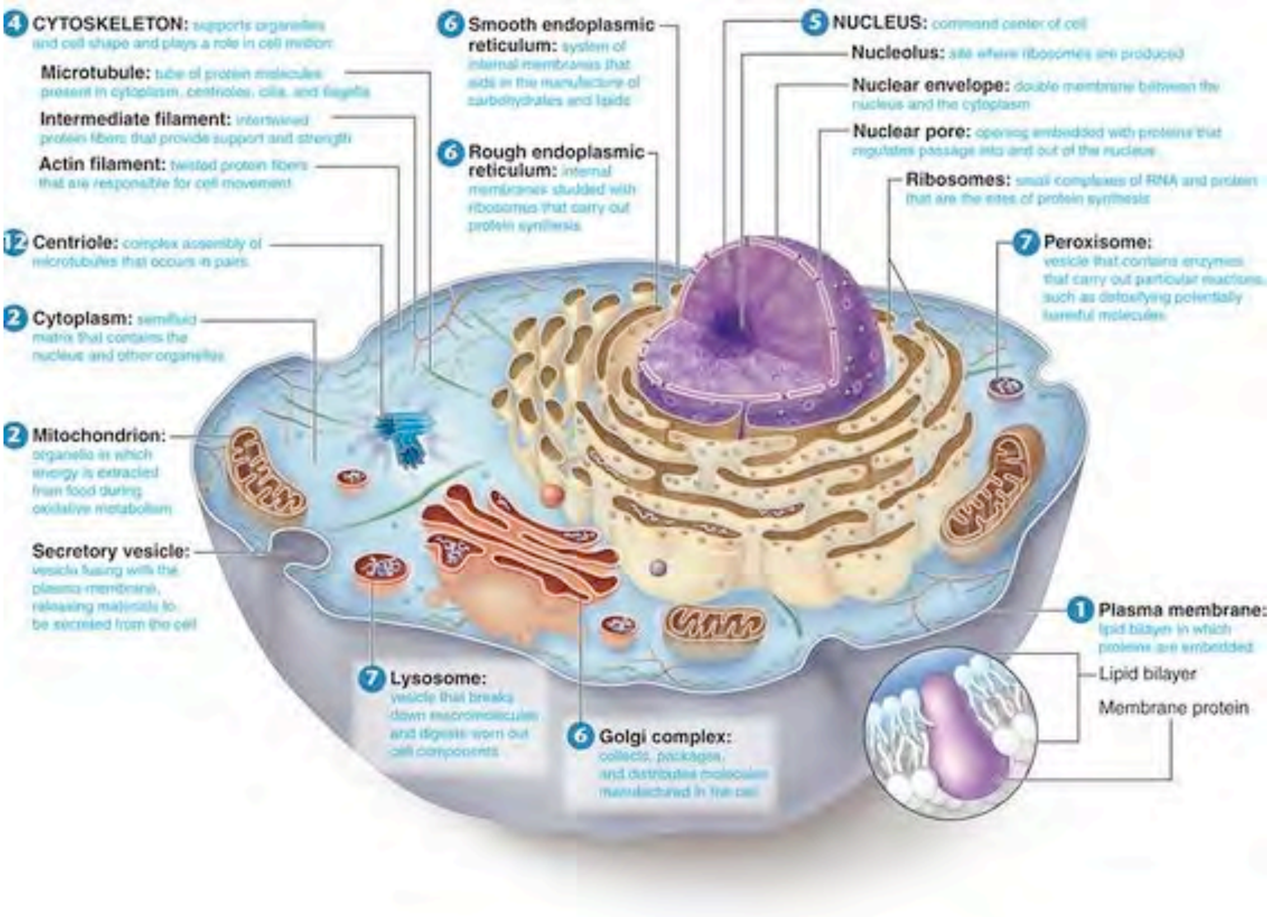
Based on your data and observations, what are some of the differences between normal cells and cancer cells?

Which type of cancer shows the most aggressive growth? Explain.

When studying cell division in tissue samples, scientists often calculate a mitotic index, which is the ratio of dividing cells to the total number of cells in the sample. Scientists often calculate the mitotic index to compare the growth rates of different types of tissue. Which type of tissue would have a higher mitotic index, normal tissue or cancerous tissue? Explain.

Task 2: Comparing Normal Cells to Cancerous Cells

Study the following diagrams and information.

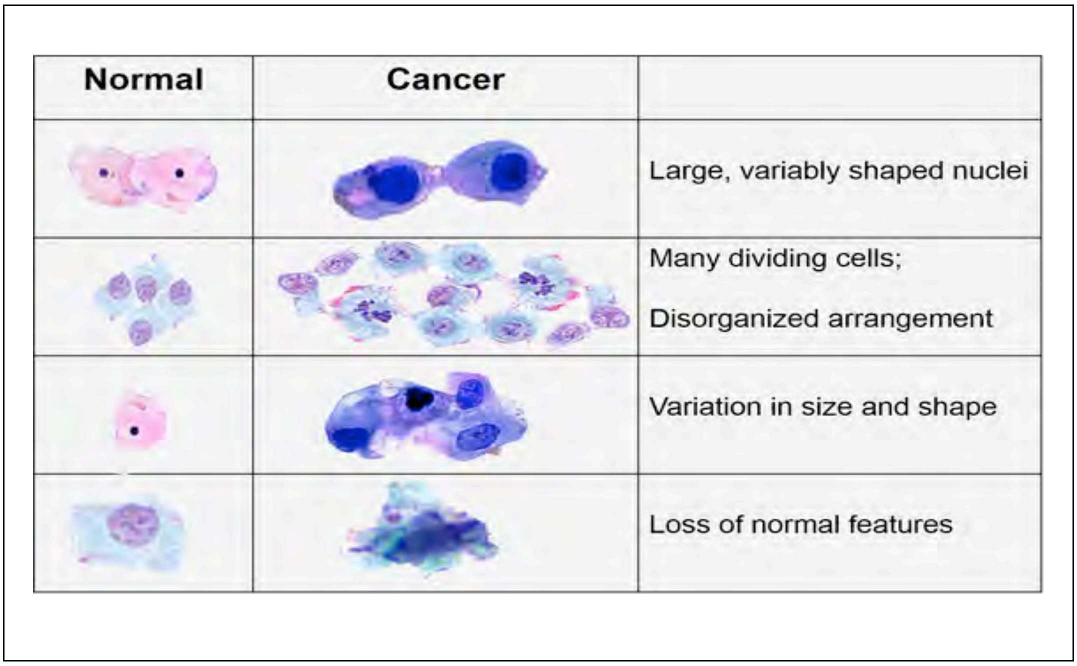


Structure of cell and organisation of cells into tissues.
https://i.pinimg.com/originals/b9/70/25/b97025166e2c7d7132afbeb44aaced1d.jpg

Normal Cells	Cancer Cells
• Highly organised	• Show varying degree of disorganization, proportional to severity of disease
• Cells have specific structure and function	• Cells have lost their structure and function
• Normal genetic material	• Abnormal genetic material, often DNA/chromosomal duplications, rearrangement of DNA, mutations

Normal Cells	Cancer Cells
• Cells have strong contacts with each other	• Cells have lost their adhesion to each other
• Cells are attached to the extracellular matrix (environment)	• Cells detach from the extracellular matrix
• Cells can't move	• Cells become motile
• Cells don't secret enzymes unnecessarily	• Cells secrete enzymes that enable them to digest their way out of their tissue and eventually get into the blood
• Cells have a distinct internal structure	• Cells change their intracellular structure e.g. lose keratin, lose cell-adhesion molecules
• Few Immune cells	• Immune cells invade cancerous tissue to try and get rid of abnormal cells
• Normal melanocyte	• Dead cells and necrotic tissue (due to inadequate blood supply)
• Basement membrane intact	• Basement membrane /ECM broken

http://biology.about.com/od/cellbiology/ss/normal-cells-cancer-cells.htm
http://www.cancerresearchuk.org/about-cancer/what-is-cancer/how-cancer-starts/cancer-cells

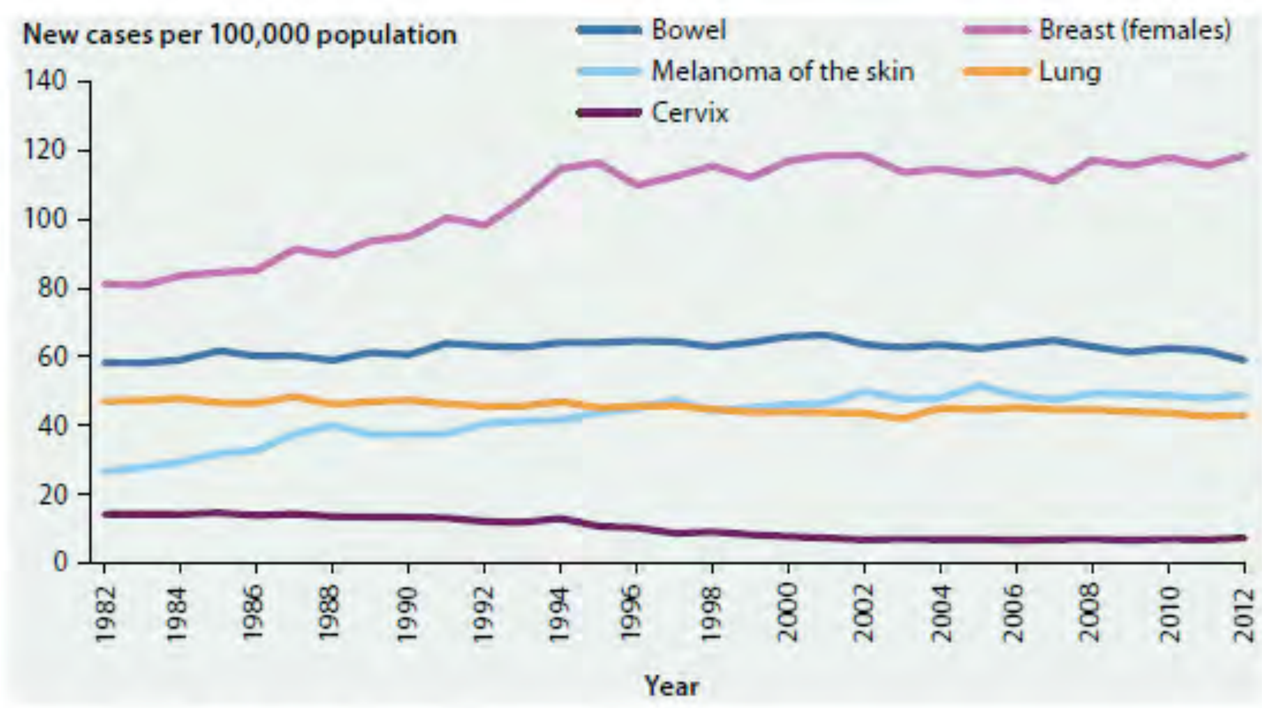


Complete the following table that outlines 5 differences and 5 similarities between normal and cancer cells.

	Normal cells	**Cancer cells**
Differences		
Similarities		

Task 3: Interpreting graphs and drawing conclusions

Study the following graph on incidence of various cancers in Australia.



Source: AIHW Australian Cancer Database 2012.

Age-standardised incidence rates of selected cancers, 1982-2012.
https://www.aihw.gov.au/reports/australias-health/australias-health-2016/contents/health-indicators

Referring to number of new cases per 100, 000 population, which 2 cancer types show relatively few new cases per 100,000 population?

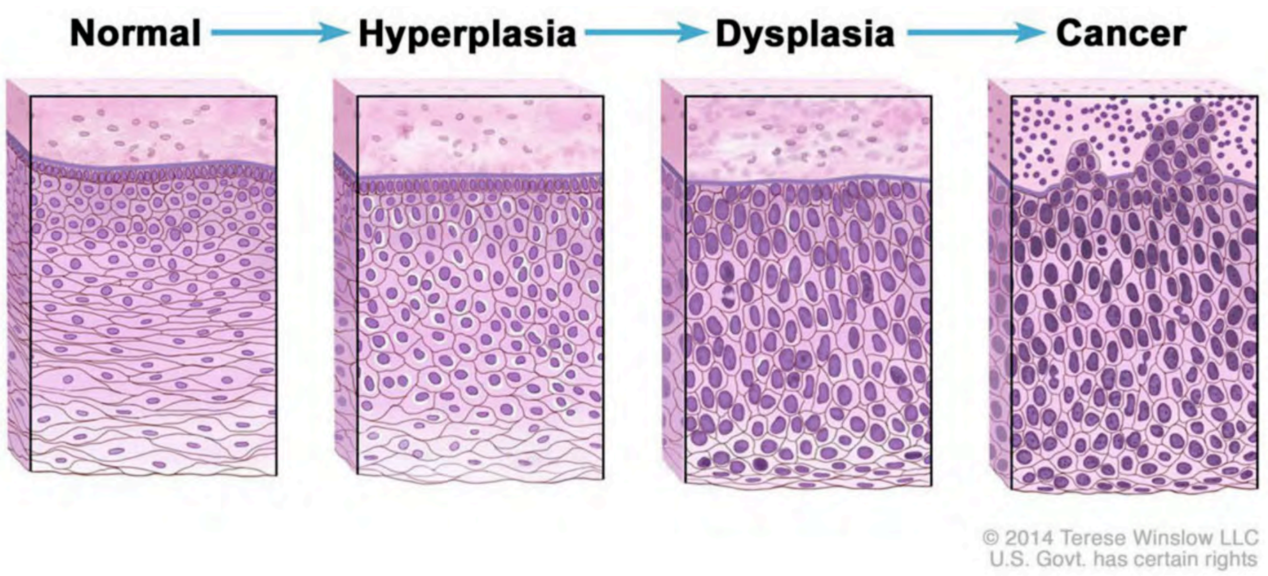
New cases of cervical cancer show a slight decrease from 1990 -2010. Can you explain this decrease?

The number of new cases of melanoma of the skin showed an increasing trend between 1982 – 2002. Calculate the percentage increase over this time. Can you explain this increase?

Research the causes of melanoma of the skin.

Task 4: Representation of skin cell with cancer

Label a skin tissue indicating: various cell layers; highlighting the nucleus; cell types; junctions; and blood vessels of normal healthy tissue.



Represent how you think a skin with melanoma will look.

Task 5: Digital animation

Create a digital story to describe the progression from healthy tissue to cancerous tissue in skin melanoma. Animate the process that cells take to move from healthy tissue to skin melanoma. You may like to develop 3D models using the equipment provided or you may like to use a white board and drawing to help in student explanation.

Step 1:

What does an animation look like? Below are two tutorials about how to use animation

- https://youtu.be/X33pwiUT4lQ
- https://www.youtube.com/watch?v=X_M468S86HI

Step 2:

Use the storyboard template below to construct the plan for how you will represent the transition. You will need to include the visual representations, the narration, and the camera actions/effects. Don't forget to include title slides and credits (including references).

Step 3:

Use STOP Motion (a free software program) downloaded to your device. Be sure that you know how to use the program – do some test shots to practice the set up. Consider the ipad/camera set up:

- Positioning the camera (retort stands, rulers, masking tape)
- Taking the shot (don't move the ipad)
- Watch the lighting (shadows)
- Position the animations (tape things down)
- Use the onion skin to check the shot
- Plan the title and credits from the start (don't plan to insert later)

Step 4:

Narrate the video showing the progression of cell changes from normal to cancerous tissue.

Materials

- STOP Motion software
- Ipads or own devices
- Butchers paper, A3 paper, coloured paper
- Pencils, textas, coloured pencils, crayons
- Pipe cleaners
- Modelling clay
- Pop sticks, skewer sticks, polystyrene balls
- Glue sticks, sticky tape, elastic bands, white tac, string

Conclusion to all activities

Write a paragraph outlining the following.

- Why is cancer a health issue/biological problem and why all this research and focus into cancers?
- Explain how cancer is an imbalance of homeostasis.
- What do statistics tell us about the prevalence of certain cancers in Australia?
- How does cancer arise and spread?
- What are some of the cures of cancers?

Extension

Research one other cancer such as breast, bowel, and lung and outline the specific features of this type of cancer, causes and possible treatments.

Acknowledgements

The contributions of Peta White and Kieran Lim to the development of this laboratory learning activity are gratefully acknowledged.

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