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SciTalk

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Our microbiomes affect what we are

Your propensity to gain weight, the regularity with which you pass wind, the number of blemishes on your skin, and much more, are not your fault – you can blame your microbiome (at least in part)! But before you feel like evicting your microbiome, you need to realise how much you need them, e.g. for digesting food, keeping the immune system healthy, regulating hunger and making you feel full, producing chemicals when we are stressed, and much more.

From birth, humans are rapidly colonised by a plethora of microbes. Indeed, in an adult human, the microbes living on and in our body, our microbiome, outnumber our cells by ten times [1]. While the majority of these microbes are bacterial, fungi and archaea can also be present. Each human's microbiome is unique. Your first colonisation is significantly influenced by your birth – vaginal vs caesarean and hospital vs home delivery. Throughout life, microbiomes vary in response to the people with whom we interact, diet, antibiotics, sleep patterns, stress, hormones, etc.

Our microbiome resides on most 'external' parts of our body – our digestive system, skin, ears, nose, tear ducts, hair follicles, and urinogenital tracts are prime real estate for the many microbes that symbiotically reside on us. They have a mutualistic relationship, whereby both parties are interdependent and gain benefits through ongoing interaction. Many enzymes produced by microbes influence our digestion and health.

Research suggests that variations in one's microbiome are linked to problems such as obesity, acne-prone skin, stress responses and more [1, 5]. Since subtle changes to the microbiome can cause disease, recent research has begun to focus on identifying ways to positively manipulate the microbiome.

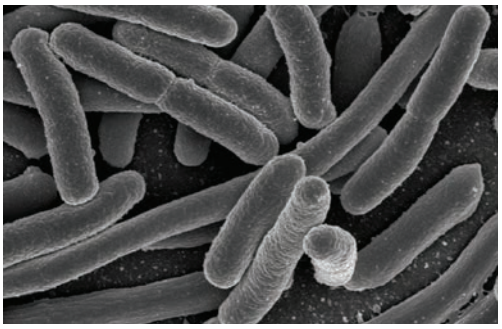

Figure 1 SEM of *Escherichia coli*, one of many species of bacteria in the human gut.
[Credit: Rocky Mountain Laboratories, NIAID, NIH (Wikimedia)]

Microbiomes and obesity

Intestinal microbes can be difficult to culture in a lab setting. This has led to the use of sequencing technology and metagenomic analysis [see Box 1] to identify the different types of microbes present. This sequencing specifically focuses on the 16S rRNA genes. The exact DNA sequences in the 16S rRNA genes differ between each species, allowing them to act as a microbial 'fingerprint' for identifying the microbial species present. These technologies have shown that the human intestine is predominantly colonised by two bacterial divisions:

... continued page 9

★ 2016 editions Past HSC Questions & Worked Solutions ... see p7 ★

INSIDE THIS ISSUE ▸▸▸▸

★★ ATTENTION ★★

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See pages 1, 9 & 12

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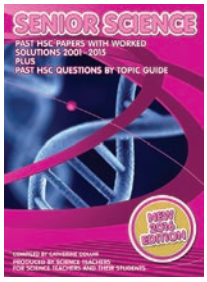

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Winner for *SciTalk 1/16*

Chris Hansford, Domremy College, won *Chemistry Past HSC Papers & Worked Solutions 2001-2015 (rrp $39.95)*, published by Odlum & Garner.

Diary Dates

2016 International Year of Pulses: http://iyp2016.org

Tour dates & towns for Shell Questacon Science Circus 2016: www.questacon.edu.au/outreach/programs/science-circus

Nyholm Lecture series 2016: www.raci.org.au/branches/nsw-branch/nyholm-youth-lecture-series

MAY 2016

6, 20, 23, 30 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

During Term 2 Crystal Growing Competition 2016 (RACI NSW) growing period. Closing date: 1 July. Details: www.raci.org.au/branches/nsw-branch/nsw-crystal-growing-competition/

14 Astronomy Open Night: Macquarie Uni, 6:30–10 pm, www.physics.mq.edu.au/astronomy

b/w 18–25 Big Science Competition: www.asi.edu.au/bigscience/ Close date:20/4/16. Ph: 6201 2552

JUNE 2016

3, 6, 10, 17, 20 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

various dates NSW Schools Titration Competition. Details: www.nswtitration.com/Home.html

5 World Environment Day

21 Winter Solstice (8:34 am AEST)

JULY 2016

1 Closing date Crystal Growing Competition. (For details: see above in May)

3–6 CONASTA 65 in Brisbane: 'Superheroes of Science: Unmask your potential', asta.edu.au/conasta

21 ANCQ (formerly the National Chemistry Quiz): www.ancq.com/home.aspx

AUGUST 2016

3 Chemistry Olympiad Exam. Close date: 20/7/16. Ph: 6201 2552, www.asi.edu.au

5 Earth Science Olympiad Exam. Close date: 20/7/16. Ph: 6201 2552, www.asi.edu.au.

5 Jeans for Genes Day. www.jeansforgenes.org.au/

8 Biology Olympiad Exam. Close date: 20/7/16. Ph: 6201 2552, www.asi.edu.au

10 Physics Olympiad Exam. Close date: 20/7/16. Ph: 6201 2552, www.asi.edu.au

12, 15, 19 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105 – come on any of these dates to celebrate National Science Week

13–21 National Science Week. Theme: Drones, droids & robots. www.scienceweek.net.au/schools/

SEPTEMBER 2016

3–11 National Seaweek 2016. www.mesa.edu.au/seaweek.asp & www.ausmepa.org.au

12, 16 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

23 Spring equinox (12:21 am AEST)

OCTOBER 2016

11–17 Earth Science Week. www.earthsciweek.org

13 HSC exam period commences ... ends 4 November

14, 17, 21 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

21 Biology Teachers' Professional Development day. Enquiries: Human Disease Museum, UNSW

22 National Schools Titration Competition. www.raci.org.au

24, 28, 31 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

NOVEMBER 2016

11, 14, 18 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

21, 25, 28 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

DECEMBER 2016

1–16 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

21 Summer solstice (9:44 pm AEDT)

JANUARY 2017 National Youth Science Forum. Forms to local Rotary club by 31/5/16, interviews from July. Only for Yr 11 in 2016. Enquiries: 6125 2777, email: nsss@anu.au, www.nysf.au/

While all dates have been checked to ensure that information in DIARY DATES is correct, no responsibility will be accepted by the publisher or Editor for any omissions or inaccuracies in it.

Update on BOSTES matters

Teachers should regularly check the BOSTES website *www.boardofstudies.nsw.edu.au* to ensure they have the latest information – on syllabuses, past exam papers, news, Official Notices, statistics archive and more.

Make sure you have updated yourself on the following BOSTES matters:

- *Senior years syllabus review* [25-4-16]
  A Consultation Report summarising key matters and feedback received from each Draft Writing Brief will be published in 2016.
- *Stage 5 & Preliminary course student work samples to be retained* [BOS 16/16]
- *Minor edits to Science Performance Band Descriptors* [BOS 20/16]
  Stage 6 Biology and Earth & Environmental Science have revised Science Performance Band Descriptors from 2016 HSC – these are in BOSTES website's syllabus section.
- *HSC 2016 timetable*
  This is available on BOSTES website.
- *Personalised exam papers* [BOS 24/16]
  For 2016 HSC, Senior Science will have personalised question/answer booklets/or writing booklets for Sections 1 & II.

You can also log in to have the weekly BOSTES Bulletin emailed to you.

BOSTES enquiries
Ph: 9367 8111, fax: 9367 8484
www.boardofstudies.nsw.edu.au

Science contact: Inspector Science, K–12

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* * * * *

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... Harry F Banks (1896-1984)

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This program relates to the *Shipwrecks, Corrosion and Conservation* option. Students attend an AV presentation on conservation and restoration, including footage taken during the recovery of material from HMS *Bounty*. Students then participate in a hands-on workshop focusing on desalination of metal objects, metal and corrosion product identification, methods of protecting metals and rates of corrosion.

This is followed by a guided tour of shipwreck material in the museum. Students may also visit the destroyer HMAS *Vampire* and submarine HMAS *Onslow*.

Program is 4 hours, at a cost of $22.00 per student (teachers free).

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AUSTRALIAN NATIONAL MARITIME MUSEUM

National Science Week
13–21 August 2016

Plan to participate in this annual event, so that your students can enjoy and explore the wonders and benefits of Science. The 2016 schools' theme is *Drones, droids and robots*. There will be many Science Week happenings. Details will be available in 2016 at:

www.scienceweek.net.au

Why not celebrate 2016 National Science Week by going on a Science excursion? You could go to a fun park excursion through *Physics is Fun* to Luna Park Sydney on 12, 15 or 19 August 2016, or to one of the other excursion venues on this page for National Science Week.

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Einstein's gravitational waves detected at last

Nearly 100 years after Einstein predicted their existence, gravitational waves have finally been directly detected, thus confirming much theoretical work, including Einstein's General Theory of Relativity.

Gravitational waves are 'ripples' in the fabric of space-time caused by some of the most violent and energetic processes in the Universe. Einstein predicted them in 1916 in his general theory of relativity. His mathematics showed that extremely large accelerating objects (such as neutron stars or black holes orbiting each other) would disrupt space-time in such a way that 'waves' of distorted space (gravitational waves) would radiate from the source and propagate through the Universe, and so reach Earth (like waves moving away from a stone thrown into a pond). However, Einstein suggested that by the time they reach us, these disturbances would be so weak that scientists might never detect them.

Gravitational waves were indirectly confirmed by US physicists Taylor and Hulse, who received a Nobel prize in 1993 for their 1974 discovery of this. They tracked radio pulses emitted by a pair of neutron stars orbiting one another. They measured the shifts in the pulses' timing and found that they accurately agreed with Einstein's predictions of how gravitational waves would carry energy away from the event.

Direct confirmation of the existence of gravitational waves was finally achieved in September 1915 by physicists working at the Laser Interferometer Gravitational-Wave Observatory (LIGO). They detected the gravitational waves produced when two black holes spiralled towards each other and merged. The origins of these gravitational waves would have been extremely violent. However, by the time the waves travelled about 1.3 billion light years to reach LIGO on Earth, they were not disruptive as they were millions of times smaller, akin to the size of an atomic nucleus.

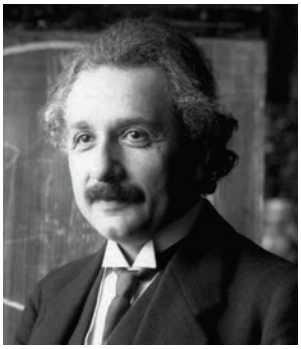

Figure 2 Albert Einstein
[Credit: Frank Schmutzer, 1921

This direct detection of gravitational waves was not possible until the recent development of detectors with sufficient sensitivity to make inconceivably small measurements, such as the interferometers at LIGO (see Box 2).

Scientists now hope to be able to use this gravitational-wave technology to learn more about objects that produce them, including black holes, neutron stars and supernovae.

References

- *www.ligo.caltech.edu/*
- *www.nature.com*
- *New Scientist Feb 2016*
- *BBC Science 11 Feb 2016*

Box 2: LIGO has two very widely spaced interferometers in the US – one in Washington State, the other in Louisiana.

Laser beams bounce between mirrors at opposite ends of two perpendicular, 4 km long, vacuum tunnels in each facility. When a gravitational wave passes LIGO, the tunnels deform slightly, so the distance travelled by each beam changes. So they no longer cancel out. This produces a measurable signal at the detector.

While LIGO is US-led, it collaborates with over 80 similar observatories worldwide, such as EGO (European Gravitational Observatory) in Italy, Max Planck Institute in Germany, etc, so that any signals can be independently verified,

New elements in Periodic Table

The discovery of elements 113, 115, 117 and 118 has finally been ratified by IUPAC. So they are now officially part of the January 2016 version of the IUPAC Periodic Table. Hence the 7th period of the Periodic Table is now complete. If any heavier elements are discovered, they will need to be in a new 8th period of the Periodic Table.

The new elements 113, 115, 117 and 118 can now be named. IUPAC allows the laboratory that is accepted as first synthesising the new element to be given the naming rights. Element 113 will be named by the RIKEN collaboration team in Japan. The Lawrence Livermore National Laboratory (USA), Joint Institute for Nuclear Research in Dubna, Russia and Oak Ridge National Laboratory (USA) will jointly name Elements 115 and 117, while the first two of these organisations will name element 118.

IUPAC rules allow new elements to be named after a mythological concept, a mineral, a place or country, a property or a scientist. IUPAC checks proposed names for consistency, ambiguity and translatability into other languages before the names are adopted and the temporary names currently in use are replaced by the formal names. That process will occur over the coming months.

Elastin mystery solved

Elastin is a highly elastic protein in connective tissue and allows many tissues in the body to resume their shape after stretching or contracting. Its flexibility allows skin to stretch and twist, blood vessels to expand and relax, and lungs to swell and contract with each breath. Elastin is also very important in elastic ligaments and cartilage, the skin and bladder.

During a person's life, the elastin in a blood vessel, for example, will go through an estimated two billion cycles of pulsation. How elastin achieved this flexibility remained a mystery – until now. A team of researchers at the University of Sydney, MIT in the US and the University of Manchester in the UK has carried out an analysis that solved this question and revealed the molecular motions of elastin. To do this, they used synchrotron imaging along with a combination of computer modelling and laboratory work.

These scientists discovered the dynamics were complex and surprising. Elastin consists of scissor-shaped molecules of a protein called tropoelastin, which are strung together in a chain-like structure. The scissors-like appendages of one molecule naturally lock onto the narrow end of another molecule, 'like one ballerina riding piggyback on top of the next'. This process continues, building up long, chain-like structures. These chains rapidly weave together to produce the flexible tissues that our lives depend on – from skin, to lungs and blood vessels.

This discovery could prove useful medically as it may help to explain why blood vessels become weakened in people with certain disease conditions. While these findings relate to one particular protein and the tissues it forms, the team said the research may help in understanding a variety of other flexible biological tissues and how they work. It may also help in the design of new materials to replace those that are faulty in our bodies.

Reference: • sydney.edu.au/news-opinion/ (6 Feb 2016). Study explains elastin's remarkable movements.

A student is not
a container you
have to fill,
but a torch you
have to light up.

… Albert Einstein (1879-1955)

Oxygen-18 not radioactive

Oxygen-18 (O^{18}) is NOT radioactive – yet the myth still persists that it can be used as a radioactive tracer. But it cannot!

O^{18} is a stable, naturally occurring isotope of oxygen that makes up 0.205% of naturally occurring oxygen. So O^{18} is NOT a radioactive isotope, and therefore *cannot* be used as a *radioactive* tracer.

The use of tracers and radioactive tracers is poorly understood by HSC examiners, teachers and students. Several HSC texts, a past HSC Biology exam, plus a number of BOSTES sample HSC Biology answers have wrongly stated that O^{18} is radioactive and can be used as a radioactive tracer*.

However, O^{18} can be used in plants as a 'tracer' to study photosynthesis, e.g. O^{18} can be given to plants either incorporated in the water or in the carbon dioxide (CO_2). The released oxygen can then be tested for O^{18} using a mass spectrometer. When this is done, it shows that the oxygen produced comes from water taken up by the plant, and not from CO_2 taken in from the air. This was discovered in 1940 by Ruben *et al* when they used O^{18} as a 'biochemical tracer' to label the water and then the CO_2 used in photosynthesis.

* as in 2003 HSC Biology paper Q34 (c)(ii) and a number of BOSTES sample HSC Biology answers, e.g. 2015 Q36(e) and 2014 Q35(d).

Only half our nose works

The nasal cycle was first noted by Richard Kayser, a German nose specialist, or rhinologist, back in 1895. He observed that humans experience an often unnoticeable alternating of partial congestion and decongestion of the nasal cavities and an alternation of airflow from one side of the nose to the other. This cycle takes from 40 minutes to several hours to run and is under the control of the autonomic nervous system.

The nose accomplishes this switch via erectile tissue in the turbinates within your nose. This tissue is very similar to the erectile tissue in a penis or clitoris. As it swells up in one nostril, thus blocking it, the erectile tissue in the other nostril will shrink, opening it up for breathing. Researchers have found that if a person is lying on one side, the turbinates on that side will swell up. This might be due to sensors in your chest and pelvis.

Why this cycle occurs, is not well understood. Suggestions are that it enables cells and glands to rest/recharge, or it helps to keep the nose moist, or it helps with smell.

References: • White DE, *et al* (2015. Model demonstrates functional purpose of the nasal cycle. • ABC Science (2000). Dr Karl 'Nostrils smell differently'. • Eccles RB (2000). The nasal cycle in respiratory defence. Acta Otorhinolaryngol Belg. 54(3):281-6

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Electri-fried birds

Dozens of birds are often seen sitting on electricity wires all facing the same direction and are not harmed by doing this. When a bird is perched on a single wire it does not get electrocuted as the voltage difference between its feet is negligible. However, sometimes a large bird, such as an eagle or pelican (or sometimes a fruit bat) makes contact between two electrical wires, or an electrical wire and the insulators at a power pole – then kaboom … the wires short circuit causing a blackout and a cremated corpse is left as evidence of the cause of the blackout. Possums are also responsible for similarly caused blackouts in electricity sub-stations.

Ever since networks of power lines were set up to transmit electricity (in the late 1800s), birds have caused problems. By 1923, the cause of many previously unexplained blackouts was discovered by Harold Michener – an electrical engineer, who also happened to be a keen bird watcher. By chance, he either spotted the cause, or perhaps was 'spotted' by the cause – which turned out to be bird excrement. It was found that large birds, such as eagles, 'unburden themselves' as they take off into flight. By voiding as they take flight, birds get rid of unnecessary load and make lift-off easier. Their 'streamers' of conductive excrement allow a brief high current to flow through it. This results in the streamer being vaporised, thus leaving no evidence as to the cause of the blackout.

Large birds can produce white arcs of excrement that are up to 2 m long. Since high-voltage can leap a fair distance from a transmission wire, this problem has increased as higher transmission voltage has become more commonly used and it enables the sparks to bridge a bigger gap to passing 'streamers'. Roosting birds have also become a problem, as power poles provide a great location for constructing a nest. Such birds generate mounds of bird poo that build up over time on the tops of power poles and on the insulators below regular perching spots. Dried poo is converted into conductive goo by light rain. This can result in short circuits, especially in substations. Such mounds of bird poo can build up considerably over time, with some reaching a metre or more in height!

A perfect solution to avian strikes on our electricity supply is elusive – and many birds are protected. So methods that do not harm birds need to be found. While metal spikes deter birds on buildings, this is not suitable for electricity grids as metal spikes conduct electricity and plastic spikes deteriorate quickly. It has been found that the construction of 'nesting poles with large platforms' adjacent to power lines are more attractive to roosting birds and so this method can deter birds from building their nests on the top of power poles. This method was used in conservation efforts for the endangered European storks that were frequently being 'fried' when their huge nests bridged the gap between electricity wires. As a result, stork numbers are now recovering.

Figure 3 Great blue heron flying and pooping
[Credit: David Bygott]

New T-shaped pylons with a monopole design were recently developed in Denmark. The conductors are held out to the side of a central pole by angled insulators, and so will not be directly underneath any bird perching spots. These pylons are being trialled by the UK's National Grid – and they will have less visual impact on the landscape than the steel lattice pylons they are replacing.

References: • *NewScientist* 19/26 Dec 2015 'Electrical discharge'. • *www.theguardian.com/environment/2015/apr/09/new-style-of-uk-electricity-pylon-launches*

... continued from page 1

the *Firmicutes* and *Bacterioides* [9]. However, their relative abundance differs between obese and lean individuals.

The obesity epidemic in the Western world prompted research into identifying the differences in microbiomes of obese vs lean mice, as well as in obese vs lean human volunteers. Biochemical analysis suggests that the microbiome of obese mice is more efficient in extracting, using and storing energy from food consumed [9]. Furthermore, colonising germ-free mice with the microbes associated with obesity resulted in significantly higher body fat [9]. This suggests that while two humans may consume identical diets, differences in their microbiome can cause variations in the energy harvested from food, energy use and energy storage.

Obesity is also known to have strong links with genes, high energy intakes and sedentary lifestyles. While these factors can be difficult for individuals to change, medical treatments may become available to change their microbiome to aid weight management.

Microbiomes and acne

Recent research also suggests that our microbiome plays a significant role in healthy skin [3]. Studies comparing the microbiome of acne-prone individuals to those with clearer skin implicate the absence of particular strains of bacteria (*Propionibacterium acnes*) to an increased propensity for skin problems. While this finding does not negate the influence of other factors such as hormones, it is a significant co-contributing factor [3]. Further research is being conducted to develop skin treatments that adjust an individual's microbiome to help reduce acne.

Figure 4 Acne on a person's back
[Credit: James Heilman, MD (Wikimedia)]

Microbiomes and 'poop' transplants

Having a wide variety in one's microbiome has been found to help prevent a number of diseases. A now established treatment for a number of intestinal problems involves the transfer of faecal matter (also known as a 'poop' transplant) to alter the microbiome by introducing desirable microbes.

Role of diet on microbiomes

While most people are now aware that excessive antibiotic use is harmful to our microbiomes, few realise the impact of eating choices. There is growing recognition of the role of diet in modulating the composition and metabolic activity of our microbiomes, which in turn can impact health. A diverse and thriving population of beneficial gut bacteria helps to keep harmful bacteria at bay by competing for nutrients and sites of colonisation.

Using mice, it has been shown that a high level of dietary fibre was needed to maintain the diversity of their microbiome and this affected their offspring [7]. In other mice studies, artificial additives, e.g. sweeteners, preservatives and emulsifiers, commonly used in processed Western foods, resulted in the gut microbiome being altered, and caused obesity and inflammatory bowel disease [2].

Heavily processed foods are treated with chemicals to prevent microbial growth and regular consumption of such foods has also been shown to reduce diversity in the microbiome. This is one of the hypothesised causes of the reduced diversity in the microbiomes of Western societies compared to cultures that eat primarily whole foods. Likewise, increased levels of allergies in Western societies have been hypothesised to relate to the reduced diversity in our microbiomes due to diet, antibiotics and increased hygiene measures.

Several studies [8] have also examined the gut microbiomes of individuals with autism, and support the idea of a strong mechanistic link between the human microbiome and autism-related behaviours.

* * * * *

Current research is only touching the tip of the iceberg – much more needs to be done to fully understand our microbial-human ecosystem.

Related classroom resources on the microbiome can be found on the Learn. Genetics website, produced by the University of Utah – 'The Human Microbiome' section has numerous engaging information pages, videos and interactives. Also, the AsapSCIENCE YouTube channel has a couple of interesting related videos, entitled 'Is there a pimple cure?' and 'You're not what you think you are'.

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Box 1 Metagenomics (also known as environmental and community genomics) is the genomic analysis of microorganisms by direct extraction and cloning of DNA from an assemblage of microorganisms.

– by Katrina Garner

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WINNER: Catriona Chaikin, Hornsby High School won a Luna Park Sydney family pass for *SciTalk No. 1–2016.*

Astronomy

Autumn into winter skies for Term 2

... Robert Garner

As autumn progresses towards winter, it is getting darker much earlier. This makes Term 2 a great time of the year to send your students out to look at the night skies, before it gets too cold

The Planets

Only Mars and Jupiter are visible in the evening sky throughout Term 2. Saturn is visible in the early morning sky in May, all night in June and is visible in the evening sky over the winter months.

On 10 May, Mercury will transit across the face of the Sun, in the third of 14 such transits this century. Unfortunately, it will not be visible from Australia. You will have to travel to the eastern USA, Western Europe, Greenland or the Atlantic or Arctic Oceans to observe this transit. The next transits of Mercury visible in Australia are not until 2032 and 2039.

Mercury will return to the pre-dawn sky during the first half of June, rising two hours before sunrise giving an opportunity for early risers to see Mercury against a relatively dark background. Its greatest angular separation from the Sun (24°) will be on 5 June. After this, Mercury will again gradually move closer to the Sun and will disappear in the dawn twilight later in June as it moves towards the far side of the Sun. Mercury reappears in the western evening twilight mid-July.

Venus will not be seen in the evening sky until the second half of July. It will then be slightly above the western horizon, only 0.5° apart from Mercury on 17 July. However, Venus will be a little bit higher in the sky with each passing night for the rest of July.

Mars will be in opposition on 22 May (Sun and Mars on opposite sides of Earth). The closest approach of Earth and Mars occurs on 31 May when they are ~75,000,000 km or 0.5 au apart. Being closer together, Mars' apparent size at the end of May will have more than doubled since the start of March.

Jupiter is visible in the early evening north-eastern sky. In early May, Jupiter will still be moving from east to west against the background stars as it is in apparent retrograde motion. But from 10 May, it resumes its normal west to east movement against the background stars.

Saturn, the ringed planet, will be rising in the east around evening twilight during May and is visible all night as it approaches opposition on 3 June. Around the time of opposition (Sun and Saturn on opposite sides of Earth), between mid-May to mid-June, Saturn's rings appear brighter than usual. So this is a good time to observe Saturn with binoculars or, even better, with a telescope. A telescope will allow better observation of Saturn's rings and moons. Only the largest moon, Titan, can be seen with binoculars.

Constellations

May should be a good time to look at the constellation *Canis Major* (the Great Dog), low in the western sky. This constellation contains Sirius, the brightest star in the night sky. The constellation *Carina*, nearby and to the left of *Canis Major*, contains the second brightest star of the night. Directly to the south, *Crux* (the Southern Cross) is high in the sky upside-down over winter. Its pointers (α-Centauri and β-Centauri) are located in the *Centaurus* constellation, to the eastern side of *Crux*. α-Centauri (the pointer on the left) is the third brightest star in the night sky. Looking towards the east, two other constellations will be rising – *Scorpius* (the Scorpion), which contains the bright red star Antares and below it, *Sagittarius* (the Archer) with its well-known 'tea-pot'. The tail of *Scorpius* contains many beautiful star clusters that can be easily seen with binoculars.

By June, *Canis Major* will have disappeared. However, the other constellations from May will be higher in the sky. By July, *Crux* will be lower in the southern sky, but will be lying on its side with the two pointers more above it.

Early risers will be able to see *Taurus* (the Bull) containing the Pleiades star cluster (seven sisters) and *Orion* (the hunter) rising in the east in the pre-dawn early hours during Term 2.

Meteor showers

The eta-Aquarids (in the *Aquarius* Constellation), associated with Halley's Comet, often rewards sky watchers with a good display– their hourly rate is often around 30 per hour. They should be visible from 19–28 May, peaking around 7 May. Viewing conditions should be favourable, as there is a new Moon on 7 May.

If you live away from city lights, a last quarter Moon on 27 July will help you to see meteor showers such as:

- Piscis Austrinids (in *Pisces*, 15 July–10 August, 5/hour),
- Southern delta-Aquarids (in *Aquarius*, 12 July–23 August, 16/hour)
- alpha-Capricornids (in *Capricorn*, 3 July–15 August, 5/hour).

Remember, the best time to view meteors is generally a few hours pre-dawn, i.e. after 1:00 am in the morning. It is good to get away from city lights and to avoid a bright Moon.

Solstice

The southern winter solstice occurs at 8:34 am (AEST) on 21 June 2016. This is when the Sun appears to reach its most northerly position relative to the Equator, and will be directly above the Tropic of Cancer. Although the term *solstice* only strictly applies to an instant, the term is usually applied to the whole day. The word is derived from Latin: *sol* (= Sun) and *sistere* (= stand still). A winter solstice is often the shortest day of the year, but not always as the day before or following is sometimes just as short.

A few days later, on 5 July at 2:24 am (AEST, the Earth will reach its furthest distance from the Sun in its orbit (aphelion).

Using a Sky Chart / Planisphere

Remember, viewing the night skies is much simpler if you have a Sky Chart or Planisphere. See Box 1 to easily obtain one of these.

Box 1: Sky Charts & Planispheres

- You can download free sky charts each month to explore the night sky from: *www.skymaps.com/downloads.html* Make sure that you scroll down to 'Southern Hemisphere Edition'.
- A planisphere (star wheel) helps to find stars and locate constellations. These are inexpensive and available from astronomy shops, or you can download one – make sure it is for the Southern Hemisphere. While the site itself is out-of-date, there is a planisphere (star wheel) to print and use at: *http:/members.ozemail.com.au/~starrylady/resources.html*

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There are also **planetarium sessions** on the first Thursday of each month (Mar to Nov, not June) from 6:30–7:30 pm at Macquarie Uni. Tickets must be booked online. These sessions are not weather dependent.

For details & bookings, go to: *www.physics.mq.edu.au/astronomy* then look for '*Astronomical Observatory'* or '*planetarium*' in 'For the public'.

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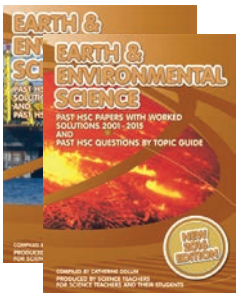

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- *SciTalk* No. 1–February 2016 ... Dec 19
- *SciTalk* No. 2–May 2016 ... April 8
- *SciTalk* No. 3–July 2016 ... July 1
- *SciTalk* No. 4–October 2016 ... Sept 23

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