Recent Developments in Science and Medicine

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Fresh fruit and vegetables reduce risk of heart disease

Instinctively we tend to know what is good for us, and what is bad for us. Breathing tobacco smoke into the lungs and drinking too much alcohol are clearly not good for us. It is also fairly obvious that exercise and a proper diet are important for our health and wellbeing. However, sometimes we seem to need solid scientific proof to back up our instinctive knowing in order to have the discipline to change our habits for the better. Hence, a recent paper showing the beneficial effect of fresh fruit and vegetables for a healthy heart is most welcome. The research carried out by Anand and colleagues (Department of Human Genetics, McGill University, Montréal, Canada) analysed 8,114 individuals from the global INTERHEART collaborative database, and 19,129 individuals from the FINRISK study, for variations in a region of chromosome 9 correlated with risk of cardiovascular disease. They then investigated the effect of diet on frequency of heart attack in these higher risk individuals. Up to two-fold higher risk was found in groups with a low consumption of fresh vegetables and fruit. Indeed eating high quantities of fresh fruit and vegetables can counterbalance the effects of having a genetic predisposition to heart disease. We should therefore take heed of the public health recommendation to consume at least five servings of fruits and vegetables each day.

Reference

Do R, Xie C, Zhang X, Männistö S, Harald K, Islam S, Bailey SD, Rangarajan S, McQueen MJ, Diaz R, Lisheng L, Wang X, Silander K, Peltonen L, Yusuf S, Salomaa V, Engert JC, Anand SS; INTERHEART investigators.
The effect of chromosome 9p21 variants on cardiovascular disease may be modified by dietary intake: evidence from a case/control and a prospective study.
PLoS Medicine. Epub 11 Oct (2011).

Your gut bugs

A recent study has shown that individual human beings have one of three different types of bacterial population in their gut. Arumugam, Ehrlich, Bork and colleagues (European Metagenomics of the Human Intestinal Tract (MetaHIT) Consortium) have identified the microbes present in faecal samples from 22 Europeans and 17 people from the United States and Japan. Each person carries a complex mix of several thousand bacterial species in their gut. The composition of the population of different bacteria varies in different people. The finding that there are these three distinct types was surprising and so far it is not known what determines distinct bacterial populations in the gut. A further 400 individuals have been analysed since the paper was published and the results are not dependent on race, age, nationality or diet. It is also unclear whether a person's gut bacteria population can change with time, either naturally or with diet or drugs. However, it is clear that our gut bacteria, which outnumber the cells in our body by ten to one, are extremely important and influence immunity, obesity, and many other diseases such as inflammatory bowel disease. Given the importance of composition of gut bacteria populations on human health it is of interest that probiotic yoghourts do not seem to make a lasting difference (see below).

Reference

Arumugam, M. et al. Enterotypes of the human gut microbiome.
Nature 12: 174-180 (2011).

Probiotic yoghurts and gut bacteria

Are probiotic yoghourts good for your health? Companies that sell foods with added ingredients that are intended to boost health or prevent illness are under increasing pressure to substantiate their claims about their products. In a study funded by US National Institutes of Health and Danone Research, McNulty, Gordon and colleagues (Washington University, St Louis, Missouri) recruited seven pairs of identical twins and one in each pair ate a popular yoghurt brand twice daily containing five strains of bacteria. They analysed stool samples 4 weeks before, 7 weeks during, and 4 weeks after consumption of a commercially available fermented milk product (FMP) containing a mixture of Bifidobacterium animalis, two strains of Lactobacillus delbrueckii, Lactococcus lactis, and Streptococcus thermophilus. They observed little effect on the resident population of gut bacteria. Perhaps this is not surprising as only several billion bacterial cells are being added to the tens of trillions of gut microbes. The scientists also fed the five bacterial strains from the yoghurt to mice and again the composition of the rodents' gut microbes was unchanged. Such findings suggest that the ingestion of additional gut bacteria in the form of probiotic foods is unlikely to be beneficial to human health.

Reference

McNulty NP, Yatsunenko T, Hsiao A, Faith JJ, Muegge BD, Goodman AL, Henrissat B, Oozeer R, Cools-Portier S, Gobert G, Chervaux C, Knights D, Lozupone CA, Knight R, Duncan AE, Bain JR, Muehlbauer MJ, Newgard CB, Heath AC, Gordon JI.
The impact of a consortium of fermented milk strains on the gut microbiome of gnotobiotic mice and monozygotic twins.
Sci Transl Med. 3:106 (2011).

The autism enigma

In the journal *Nature* November 2011, Laurent Mottron reviews recent data suggesting that autism can be an advantage in some spheres, including science. The article attracted a wealth of comments published online in *Nature* on 2 November 2011. The increasing confusion surrounding autism, its many forms and the large increase in prevalence, are discussed. Autism can take many forms ranging from profound communication and behavioural problems to normal language communication with social difficulties. Autism may even extend to include an increased intelligence and analytic capability. Some reports suggest that altered brain function in autism may be associated with a wider awareness. This could be due to less 'screening out' of what a 'normal' brain, in its attempt to simplify, would categorise as information superfluous to requirement.

The reasons for the increase in autism are unclear. They include genetic and environmental factors and perhaps the fact that the autism spectrum has become so broad in its inclusion. Among the large number of comments attracted by Laurent Mottorn's article are suggestions that when small children are put in front of television for lengthy periods they are seeing people as totally unresponsive to them – unresponsive to their movements, expressions, feelings and needs. The child is being programmed with a lack of interactive responsiveness, interpersonal communication and empathy. It is also worth considering whether the human mind, in an age of cyberspace and internet information overload, and fear of future global catastrophe, is undergoing a generic change. It could also be true that aspects of 'social dysfunction' which are sometimes associated with autism are an advantage when the social norms themselves are dysfunctional.

Indeed, many of us scientists, attracted as we are to a life of obsessional analysis of complexity, might be included in the autistic spectrum. Although autism is classified as a disability, certain aspects of autism could be an advantage in analytical professions.

However, it is important to note that the increasing self diagnosis of autistic traits as some sort of explanation for difficulties 'fitting in', and the sense of trying to be normal, which most of us feel from time to time, must in no way minimise the tragedy and suffering of severe debilitating autism and Aspergers syndrome.

Reference
Laurent Mottron. Changing perceptions: The power of autism. *Nature 479: 33–35 (2011)*
Plus comments published online 02 November (2011).

The first 1000 days – foetal and newborn environment determine health for life

Adult health is influenced by the experience of the foetus of its environment in the womb, which in turn is determined by the mother's nutrition and emotional state. After birth, our future health continues to be programmed by the nutritional, physical and emotional environment of the newborn at least up to the age of two years old. David Derbyshire reviewed the field in the Guardian on Sunday 6 November 2011. He acknowledges the excellent early work of Ethel Burnside who toured Hertfordshire on her bicycle over 100 years ago, visiting new mothers and babies to tackle Edwardian Britain's infant mortality. One in 10 babies died in the first year of life and many that survived to reach adulthood were sick and infirm. Bernside encouraged mothers to record every detail of the babies in their care and measured their weight at birth and one year later.

Using these detailed records, researchers have now shown that adult disease - heart disease, diabetes, stroke and lung problems – is correlated with the babies experience in the womb and first two years of life. Professor David Barker of Southampton University noticed a similarity between a map of heart disease in England and a map showing infant mortality in 1910. From Bernside's records (1911 to 1940) he was able to establish the foetal origins of disease. Barker tracked down 15,000 of the babies born before 1930 and compared their birth details with their adult medical histories. Men who had a low birth weight as babies, or a low weight aged one – and therefore suffering from poor nutrition – were at much higher risk of developing coronary heart disease as adults. They were more likely to have a higher blood pressure, less elastic arteries, altered stress responses and chronic bronchitis.

How are these later imperfections established in the first 1000 days after conception? The answer lies not in the genes but in the programming of the genes by the early environment. Epigenetic programming is the modification of the DNA of the genes determining whether a particular gene is on or off (see member's article by Marilyn Monk this issue). Epigenetic programming determines the specific types of cells in the body (e.g., nerve, muscle, gut). Epigenetic programming also occurs at the interface between genes and external environment – for instance, adapting the genome of the new individual to its environment in the womb and its newfound environment after birth.

Since the Barker hypothesis, developed in the 1980s, more evidence for the foetal origins of disease have come from other large cohort studies of mothers and babies, e.g., the Avon Longitudinal Study of 14,000 mothers and their children in the Bristol area which has already shown correlations such as fatter children of women who put on too much weight in pregnancy, and asthma in babies associated with the woman's anxiety during pregnancy. Recently, it has been shown from longitudinal studies going back over several generations that the lifestyles of grandfathers and grandmothers can affect their grand children's health and longevity – good evidence for Lamarckian inheritance, the transgenerational inheritance of acquired characteristics.

Shipping timetables provide evidence that Charles Darwin did not steal ideas from Alfred Russell Wallace

There is still controversy among the general public as to whether Charles Darwin or Alfred Russell Wallace was the real originator of the theory of evolution by natural selection in 1858. Wallace was developing his ideas on Ternate, one of the Indonesian islands of the Malay Archipelago, while Darwin was working on his ideas that were later to be published in 'On the Origin of Species' in 1859. Did Charles Darwin modify his ideas after he received a letter from Wallace explaining his theory? The timing of the receipt of Wallace's letter and the timing of Darwin's revelation of his theory of evolution by natural selection is crucial. For many years it was believed that the Wallace letter left the islands in March 1858 on the monthly mail steamer and arrived at Down House on 18th June 1858. Darwin immediately forwarded the letter to Charles Lyell as requested by Wallace and in Darwin's letter to Lyell he remarked on the amazing coincidence of the simultaneous development of his own and Wallace's theories.

The date of the 18th June 1858 was subsequently put in question by the receipt of another letter from Wallace in Leicester on 3rd June, but supposedly sent on the same steamer. This discrepancy suggested that Darwin secretly kept the Wallace letter for two weeks before sending it on to Lyell thus allowing him to revise his own theory of evolution. However, recent investigations of shipping timetables by Van Wyhe and Rookmaaker (historians of science at the National University of Singapore) indicate that the letter did not leave the islands until April 1858 for which the postal connections show the letter would arrive precisely on 18th June as originally thought. Thus the accusations of deceit and plagiarism on Darwin's part are not valid. Extracts from both Darwin's and Wallace's theoretical manuscripts were read at the Linnaean Society on 1st July 1858.

Reference
Van Wyhe J, Rookmaaker K. A new theory to explain the receipt of Wallace's Ternate Essay by Darwin in 1858. *Biol. J. Linnean Soc.105: 249–252 (2012).*

Climate change – ocean acidification threatens fish stocks

Oceans absorb carbon dioxide from the atmosphere to form carbonic acid. As the atmospheric carbon dioxide rises the acidity of ocean is increased. Carbonate minerals, calcite and aragonite, required for skeleton and shell formation are decreased. Therefore, marine organisms such as corals, algae, shellfish and molluscs are clearly challenged. However, until now it was not clear how acidification would affect the internal skeletons of fish. Adult fish tolerate short-term exposures to CO_2 levels that exceed those predicted for the next 300 years. But what about their embryos? Baumann, Talmage and Gobler (School of Marine and Atmospheric Science, Stonybrook University, New York) have shown that increased CO_2 levels severely reduced growth and survival rates during the early life stages of a common estuarine fish (Menidia beryllina). Exposure of embryos to CO_2 concentrations expected in the world's oceans later this century until one week post-hatch reduced average survival and length by 74 per cent and 18 per cent, respectively.

In another work, Andrea Frommel and coworkers (Leibniz-Institute of Marine Sciences, Kiel, Germany) reared Atlantic cod (Gadus morhua) larvae in three concentrations of CO_2 - present day, end of next century (year 2200) and in a more extreme condition. Exposure to CO_2 resulted in severe to lethal tissue damage in many internal organs about a month after hatching, with the degree of damage increasing with CO_2 concentration. Thus ocean acidification is an additional source of mortality, affecting populations of fish stocks that are already exploited. These findings challenge the common current belief that ocean acidification will not affect fish populations.

References
Baumann H., Talmage SC. & Gobler C.J. Reduced early life growth and survival in a fish in direct response to increased carbon dioxide. *Nature Clim. Change 2: 38–41 (2012).*
Frommel AY. et al. Severe tissue damage in Atlantic cod larvae under increasing ocean acidification. *Nature Clim. Change 2: 42–46 (2012).*

Do rodents feel empathy?

Empathy is defined as the ability to put one's self in another's emotional shoes. We see another in pain, try to understand their pain, and often want to do something to help alleviate their pain. Peggy Mason and co-workers (Department of Psychology, University of Chicago, Illinois) looked for evidence of empathy in rats. They placed a free rat in an arena with a cagemate trapped in a restrainer. After about one week, the free rat had learned to intentionally open the restrainer and free the cagemate even if they had nothing to gain. The free rat did not open an empty restrainer, nor a restrainer containing a toy rat. Interestingly, all the

female rats tested became door openers, whereas thirty per cent of males never became door openers. When given a choice to free a cagemate or open a restrainer containing chocolate they opened both restrainers and shared the chocolate. It is still uncertain where the behaviour lies in a spectrum of behaviours from emotional contagion (alleviating one's own greater sensitivity to pain triggered by another's pain) to genuine pro-social behaviour (empathy – understanding the feelings of others and voluntary action to help). Nor is it known the nature of the signal motivating the rats to free their cage-mates. We study animals to see what makes us uniquely human. The demonstrations of empathy in animals raises questions about how we humans treat our animal neighbours.

Reference

Bartal I, Decety J. & Mason P. Empathy and pro-social behaviour in rats.
Science 334: 1427–1430 (2011).

Shrinking glaciers

The melting of mountain glaciers and ice caps is expected to contribute significantly to sea-level rise in the twenty-first century. Glaciers and ice sheets contain over seventy per cent of the world's freshwater reserves and those in the Patagonian icefields of South America are thought to have contributed about ten per cent of the total sea-level rise attributable to mountain glaciers in the past 50 years. It is important to know whether recent rates of glacier recession in Patagonia are unusual relative to the past few centuries. Glasser (Aberystwyth University, UK) and colleagues (University of Exeter, UK and Stockholm University, Sweden) estimate that since 1870 the Northern Patagonian Ice Field has lost more than 100 cubic kilometres of ice, and that the Southern Patagonian Ice Field had lost more than 500 cubic kilometres since 1650. In both cases, the melt rate has increased considerably in recent decades. The San Rafael Glacier, for example, about 55 kilometres southwest of Exploradores, has retreated 12 kilometres over the past 136 years, and is still shrinking. And earlier this month, scientists used time-lapse photos to show that the Jorge Montt glacier in the Southern Patagonian Ice Field retreated by about one kilometre between February 2010 and January 2011. It is clear that the melt rate and sea-level contribution of the Patagonian Ice Fields has increased markedly in the twentieth century.

Reference

Glasser NF, Harrison S, Jansson KN, Anderson K & Cowley A . Global sea-level contribution from the Patagonian Icefields since the Little Ice Age maximum.
Nature Geoscience 4: 303–307 (2011).

Two new planets orbiting Kepler

Kepler, an amazingly powerful telescope, has discovered two new planets. The size of an exoplanet can be determined when it passes in front of (transits) its parent star, causing a decrease in starlight. The smallest exoplanet hitherto discovered has a radius 1.42 times that of the Earth's radius and hence has 2.9 times its volume. Now Fressin (Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA) and colleagues (USA and Denmark) report the discovery of two new planets, one Earth-sized (1.03R) and the other smaller than the Earth (0.87R, about the size of Venus) orbiting the star Kepler-20 (already known to host three other, larger, transiting planets). The newly discovered planets orbit closer to their star than Mercury is to our Sun, making life as we know it highly unlikely. They are rocky and composed of iron and silicate. The smaller planet orbits its star every six days. The outer planet orbits its star every twenty days and could possibly have developed a water vapour atmosphere. Neither planet appears to spin on its axis so one side would be dark with temperatures maybe more suitable for life.

Reference

Fressin et al. Two Earth-sized planets orbiting Kepler-20
Nature 482: 195–198 (2012).

Modified mosquitoes control dengue fever virus in Australia

Dengue fever is the most important mosquito-borne viral disease of humans with more than 50 million cases estimated annually in more than 100 countries. Control of dengue is currently focussed on reducing population abundance of the major mosquito vector, Aedes aegypti, but this strategy is failing and dengue incidence is expanding geographically. Since A. aegypti is active during the day, control strategies that help prevent malaria, such as bed nets, are ineffective. Now, Australian researchers, Walker, O'Neill, Hoffman and colleagues (University of Queensland, Australia and Universities of Monash and Melbourne, Australia) find that mosquitoes infected with a bacterium called Wolbachia are unable to transmit dengue fever, thus providing a novel strategy for dengue control. Infection with Wolbachia reduces the lifespan of A. aegypti mosquitoes and, in addition, Wolbachia can also directly influence the susceptibility of the mosquitoes to infection with a range of insect and human pathogens, including the dengue fever virus. In a current trial, the Australian researchers have released thousands of the modified mosquitoes in two coastal Queensland towns to see if they can halt the transmission of dengue fever. Within 14 weeks, Wolbachia had spread to more than 90 per cent of the local A. aegypti populations. The dengue-defeating mosquitoes still need to prove that they can cut transmission rates to humans. The Australian test areas have only sporadic transmission to humans. The next step will be to test the mosquitoes in areas where the impact on human transmission rates could easily be seen.

Reference

Walker T, Johnson PH, Moreira LA, Iturbe-Ormaetxe I, Frentiu FD, McMeniman CJ, Leong YS, Dong Y, Axford J, Kriesner P, Lloyd AL, Ritchie SA, O'Neill SL, Hoffmann AA. The wMel Wolbachia strain blocks dengue and invades caged Aedes aegypti populations.
Nature 476: 450-453 (2011).

Sugar is toxic

'Last September, the United Nations declared that, for the first time in human history, chronic non-communicable diseases such as heart disease, cancer and diabetes pose a greater health burden worldwide than do infectious diseases, contributing to 35 million deaths annually.' This quote opens a paper by Lustig and co-workers (University of California, San Francisco, USA) demonstrating that sugar consumption is linked to a rise in non-communicable disease with effects similar to alcohol, and arguing for the introduction of regulation by tax, limiting sales to children, and placing age limits on purchase. All countries that have adopted a western diet have increasing obesity and related diseases with 'now 30 per cent more people who are obese than who are undernourished.' Obesity is not necessarily the cause for the increase of life-style diseases (thin people also suffer from diabetes, liver disease, hypertension, strokes and cardiovascular disease) but it is certainly a marker. Today, tobacco, alcohol and diet are the major factors contributing to non-communicable disease and amongst the harmful factors in our diet, sugar is the main culprit rather than fat and salt (although fat and salt need to be targeted as well). Sugar is not a natural food for humans. In the past it was rarely available. Today, sugar is added to most processed foods. Attempts to teach children about the importance of diet and exercise at school have not been effective. Limiting availability and taxation appear to be the best strategies to control sugar consumption.

Reference

Lustig RH, Schmidt LA & Brindis CD Public health: the toxic truth about sugar. *Nature 482: 27–29 (2012).*

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