

Science Communication Competition

The Science Communication Competition is now in its seventh year. As in previous years, it aims to find young talented science writers and give them the opportunity to have their work published in *The Biochemist*. In 2015, a new branch of the competition was launched to include video entries. Overall this year's competition attracted 82 entries and these were reviewed by our external panel of expert judges. The first prize in the written category was awarded to **Harry Potter** from University of Manchester, whose article is presented here; the winner of the video category was **Alex Binks** from the University of Glasgow. Alex's winning video can be viewed at <http://bit.ly/scicommvid>.

From womb to tomb: stress across a lifetime

Harry Potter
(University of Manchester)

Stress. What does it mean to you? We probably all refer to it after a long or strenuous day at work, during a particularly heated family argument, or when thinking about our finances. But what does the word really mean, and why is it so important in our everyday lives? Can it increase our risk of developing serious health conditions such as obesity, heart disease, and lung cancer? Is it something that can affect our children as they develop in the womb? Is it even something that can affect our children's children? It may seem surprising, but the answer to all of these questions is yes.

"We all need a bit of stress in our lives. It's a survival mechanism"

Don't get me wrong, we all need a bit of stress in our lives. It is after all a survival mechanism. When we experience a stressful situation, our bodies are elegantly prepared to respond in an appropriate way. Imagine walking into work on a Monday morning, and you start to smell smoke. A bit concerning? You

walk a little further and you start to see the smoke too. Getting a little stressful in here, right? You reach the end of the corridor, and your office is on fire. You're pretty stressed right now.

As soon as you smell the smoke and see the fire, your nose and eyes send signals to a region of your brain called the amygdala, which is our body's fear and emotion centre. Much like someone calling



Science Communication Competition

999, the amygdala senses the stressful situation and sends a message to another brain region called the hypothalamus. The hypothalamus acts like a 'stress call-centre' for our body. Whenever the hypothalamus receives a stress signal, it tells our body to release stress hormones from the pituitary and adrenal glands.

"The fight-or-flight response helps us survive dangerous or harmful experiences"

This so-called HPA (hypothalamus, pituitary, adrenal) axis releases a surge of stress hormones such as cortisol and adrenaline, which allow us to either extinguish the fire like a firefighter, or run away. You may have heard of this as the fight-or-flight response, which helps us to survive dangerous or harmful experiences. So, if we need this response to survive, how can it be harmful to us? Imagine if the fire comes back on Tuesday, and every day next week, and the week after. Ok, a little bit unlikely - but for thousands, if not millions, of people, other types of chronic stress can change their health across their lifetime. When the HPA axis continually pumps out stress hormones, it changes the way we respond to stress, which can result in many different diseases such as depression, cancer, or heart problems.

The word stress comes from the Old French word 'estrece', which means narrowness or oppression. In a way, this definition still applies today - chronic or continued stress can oppress our bodies stress response system and change our biology

permanently, in ways that we have never understood better than we do now.

"Stress comes in many forms and can affect fetal development"

Across our lifetime, our bodies go through several important stages of development. Probably the most obvious is before we are born, when we are just a fetus surviving courtesy of our mother in the safe confines of the womb. But, like a lot of things, the human body is not perfect, and the womb can't always protect us to allow us to develop normally. We all know that women should avoid smoking and drinking during pregnancy, but stress can also come in many other forms. The surge of hormones and molecules released during maternal stress are thought to be sensed by the fetus and can affect development leading to diseases.

In 1944, the German-occupied western region of the Netherlands had a severe shortage of food rations. As a result, nearly every man, woman, and child was undernourished, having as few as 400 calories per day, and this was later called the Dutch Hunger Winter. Later, in the 1980s, a doctor named David Barker noticed something strange. Women who were a third of the way through pregnancy during the Hunger Winter were much more likely to have children who would grow up with serious health conditions such as obesity. And what about women who were later on in their pregnancy during the Hunger Winter? These women gave birth to children



Science Communication Competition

who would be much more likely to grow and develop mental health problems such as depression and schizophrenia. Babies who experience nutritional stress in the womb and who seem healthy at birth can often be afflicted for the rest of their lives with chronic health conditions.

But is this an isolated case? What do we know about other forms of stress during pregnancy? The answer is that we're learning more and more every day, with the help of pioneering scientific research. Pregnancy represents a critical period of brain development for the fetus and stressful situations experienced by the mother can interrupt these processes. Things like physical and verbal abuse, losing a loved one, experiencing a natural disaster, or even something as simple as catching a cold – these forms of stress are sensed by the developing fetus and can increase the chance of the child developing mental health problems such as schizophrenia, autism, and depression in later life.

Unfortunately, it doesn't stop there. Most of us know that our brain carries on developing until our mid-20's, so it makes sense that we are still vulnerable to the effects of stress throughout our lives. Like the fire coming back every day, some children experience adverse childhood experiences (known as ACEs), such as verbal, physical, or sexual abuse on a regular

basis. This is thought to permanently change the way their brain and body responds to the stress hormones cortisol and adrenaline. The number of ACEs that a child experiences can predict how likely they are to develop conditions like heart disease, illicit drug and alcohol addiction, and mental health problems like depression and schizophrenia.

"Epigenetics ... a possible mechanism by which life experiences can alter how our bodies work"

So why is this happening? Are stressful experiences ingrained in our DNA? The answer to this is both yes and no. DNA is our body's 'blueprint', and what makes us unique. This blueprint remains the same throughout our life, and acts like a script so that our bodies know what to produce to keep us alive. Scientists have recently discovered that there is another layer of information on top of our DNA, like a sheet of plastic on top of the blueprint, which can change how our DNA script is read. This discovery, known as epigenetics, is emerging as a possible mechanism by which life experiences can alter how our bodies work.

Neuroscientists have shown that when rats don't care for their pups in the week after birth, the pups grow up to have different epigenetic marks on the



DNA in their brains. This changes their behaviour as adults, and can cause them to show symptoms of schizophrenia or depression. The lead scientist from this study, Dr Ian Weaver, Dalhousie University, USA, says that rats not caring for their pups causes similar diseases to those seen in abused children.

There's plenty of scientific evidence to suggest that these life experiences can be passed onto our children through our epigenetic marks on our DNA, but what about our grandchildren? The recent migrant crisis in Europe has shown the world devastating pictures of families trying to escape war and poverty, leading to children floating in the water for days and people living on the streets and searching for food. A recent study used a scientific method known as a meta-analysis to show that the stress of being an immigrant increases the risk of developing schizophrenia not only for yourself, but more than doubled the risk for both your children and grandchildren. What can we do to stop this happening, for ourselves, and future generations?

"It's not all doom and gloom – don't stress about stress!"

Scientists are now trying to work out how life experiences affect the epigenetic status of our DNA. They hope that when they understand this, they may be able to prevent or reverse the changes that cause diseases. New technologies can measure different epigenetic marks, such as DNA methylation, which can affect how fast or slow our DNA script is read.

Since recognising the lasting effect on our wellbeing, health services have been committed to developing techniques to combat stress. It's well-known that exercise is good for you and helps us lose weight, but it also helps to prevent schizophrenia and depression, and can even ward off Alzheimer's and Parkinson's disease.

Mindfulness is a relatively new technique that can be used to help people to relax, reduce stress, and 'live in the present moment'. It's a simple technique, similar to meditating, that encourages us to ignore the busy world around us, and be aware of our body and how we're feeling. Sound a bit phony to you? Scientific studies have shown that structured mindfulness in children exposed to ACEs can significantly improve long-term health outcomes.

Mindfulness is also endorsed by the NHS, and recommended by the National Institute for Health and Care Excellence (NICE) to help fight depression.

It's not all doom and gloom, so don't stress about stress! Interest in this field of research has boomed in recent years, with many scientists looking to understand how maternal and lifelong stress impact disease development. ■

The annual Science Communication Competition is open to talented science communicators who can be undergraduate or postgraduate students; both members of the Society and non-members. Entries to in the written and video categories must be original works on a molecular bioscience topic and be targeted at the general public. Full details of the competition, including past winners and terms and conditions are available at www.biochemistry.org/GetInvolved/ScienceCommunicationCompetition.aspx

Further Reading

- How childhood trauma affects health across a lifetime, TED talk by Nadine Burke Harris (2014). Online at: www.youtube.com/watch?v=95ovIJ3dsNk
- Bourque, F., van der Ven, E. & Malla, A. (2011). A meta-analysis of the risk for psychotic disorders among first- and second-generation immigrants. *Psychol Med*, 41(5), 897-910.
- Isles, A. R. (2015). Neural and behavioral epigenetics; what it is, and what is hype. *Genes Brain Behav*, 14(1), 64-72.
- NHS resource on Mindfulness. Online at: www.nhs.uk/conditions/stress-anxiety-depression/pages/mindfulness.aspx
- Ortiz, R. & Sibinga, E. M. (2017). The Role of Mindfulness in Reducing the Adverse Effects of Childhood Stress and Trauma. *Children (Basel)*, 4(3).
- Topitzes, J., Pate, D. J., Berman, N. D. & Medina-Kirchner, C. (2016). Adverse childhood experiences, health, and employment: A study of men seeking job services. *Child Abuse Negl*, 61, 23-34.