ICATS
Education for the aroma and flavour trades

ICATS News

Winter 2021/22

Editor's Notes Deirdre Makepeace

If you are reading this then we can perhaps assume you are seeking to widen your knowledge, prompt discussion and development or just keep informed about recent industry issues and academic thinking. ICATS Founder, Dr Tony Curtis, is a staunch advocate of reading widely to support individual and corporate professional development. This edition includes reviews of books around the topics of flavour and fragrance, each with an extremely enticing title. The reviews of 'Nose Dive, 'Mouth Feel' and 'Delicious' start on page 20.

The social and environmental challenges of our time place increasing emphasis on innovation and research. The excellent events, reviewed in this edition, all aim to share knowledge as industry and academia seek to find better ways of placing better products in front of ever-more sophisticated markets. Recent editions of this newsletter have featured the industry's sustainable practices and this edition, against the backdrop of the United Nations COP26, is no different. The ongoing environmental challenges and potential 'green-chemistry' solutions are discussed by Dr Ali Green. Health and well-being also remain at the forefront as the COVID-19 pandemic continues and we hear more about 'long-covid' and particularly loss of sense of taste and smell. We are coming realise, with the support of research, just how important these senses are as marker for a range of health issues and to our wider social well-being and our identities.

Welcome to ICATS

ICATS has been providing world class distance learning for nearly 30 years. Its foundations were in the aroma trades but in 2012 the course was developed to incorporate a flavour pathway, recognising the increasing integration between the two sectors. The courses are accredited by the International Federation of Essential oils and Aroma Trades (IFEAT). From its base in Plymouth UK, ICATS runs a virtual network of academics, industry professionals and tutors supporting students around the globe as they develop their technical and managerial skills to succeed in the specialist and complex aroma and flavour industry.

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ICATS Team

From its base in the city of Plymouth, UK a core team of ICATS staff is supported by a wider virtual team to deliver a comprehensive portfolio of educational services including the Diploma Programme, workshops and continuing professional development for the aroma trades.

Dr Ali Green
Director of Studies

Dr Tony Curtis
Founder and Principal Tutor

Sharon Shand (née Heard)
Student Experience, Finance and Administration

Peter Whipps
Tutor and Past President BSP

John Forbes
Tutor, Industry Expert and Fellow of The British Society of Flavourists

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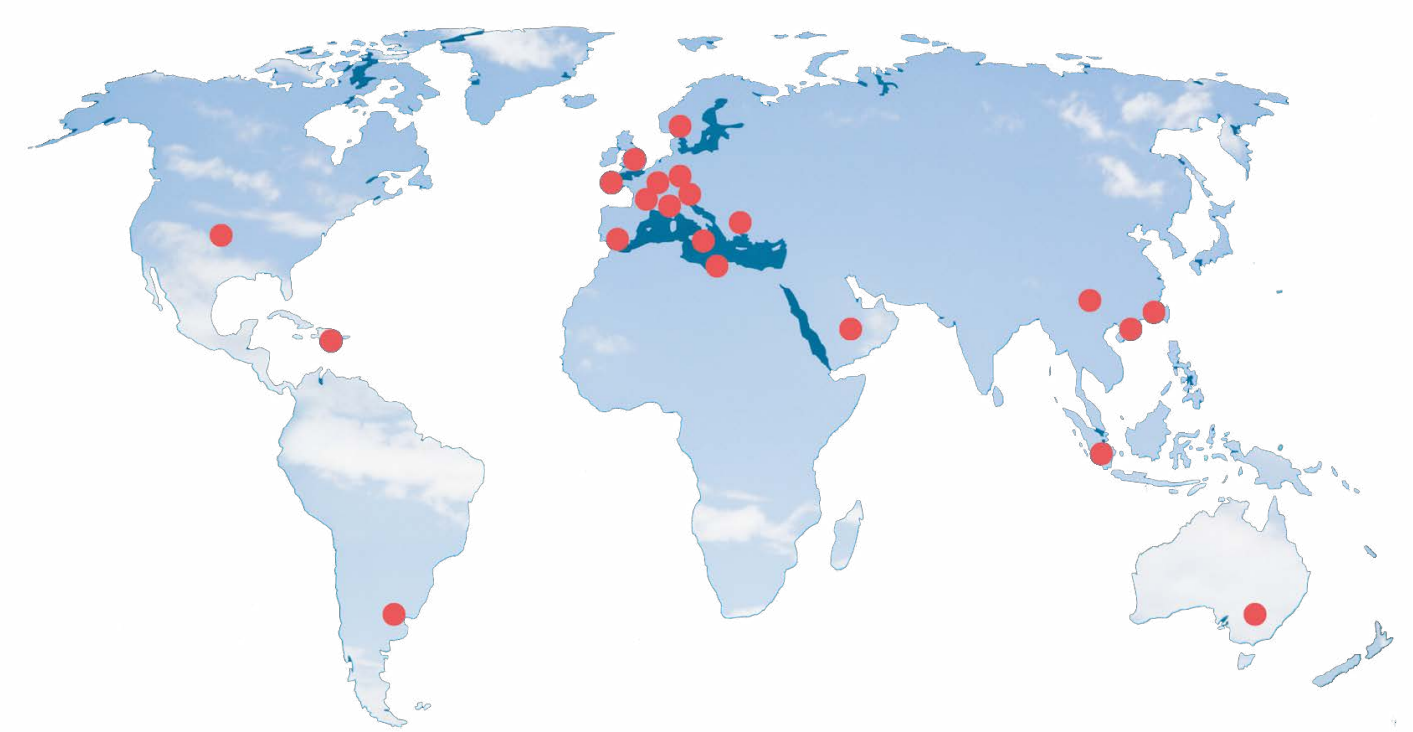
ICATS Author and Industry Expert

Dr Brian Lawrence
ICATS Author and Industry Expert

John Ayres
ICATS Author and Past President BSP

Penny Williams
ICATS Author and Industry Expert

IFEAT ICATS Diploma and Certificate



Barriers to international travel do not present any specific challenges to studying with ICATS. Our students work in locations across the globe. What ties them together is a desire to develop their technical and management skills, enabling them to contribute positively to business strategies and operation in these unusual times. The programme is delivered through distance learning, supported on a one-to-one basis by professional industry experts and educators.

The core qualification offered by ICATS is the masters-level Diploma but the approach to learning is completely flexible so students may find that the concise Certificate, or even selected units, may suit their needs better. Science graduates might select financial, marketing and project management whereas small business entrepreneurs might choose the science and technical modules to develop skills for wider oversight of the business. Each unit is assessed by a work-related assignment, allowing students' roles to be reflected in the content; adding professional context with scope to tackle live workplace scenarios.

To date, nearly 150 delegates have enrolled on the programme and they come from a wide range of roles within the sector including producers, brokers, processors, compounders, manufacturers and retailers. The units are shown here with the options for specialising in the fragrance or flavour pathways.

Not sure where to start? Contact us and we can work with you to develop and individual learning plan.

Global Units:

1 Foundation Science and Mathematics for the Aroma Trades
2 Sensory Studies and Odour Taste Language
3 Aroma Materials of Natural and Synthetic Origin
6 Safety, Regulatory and Environmental Issues in the Aroma Trades
7 Operations, Logistics and Quality Assurance in the Aroma Trades
8 Business Environment and Marketing in the Aroma Trades
9 New Product Development in the Aroma Trades
10 Project Management and the Briefing Process
11 Financial and Management Issues in the Aroma Trades

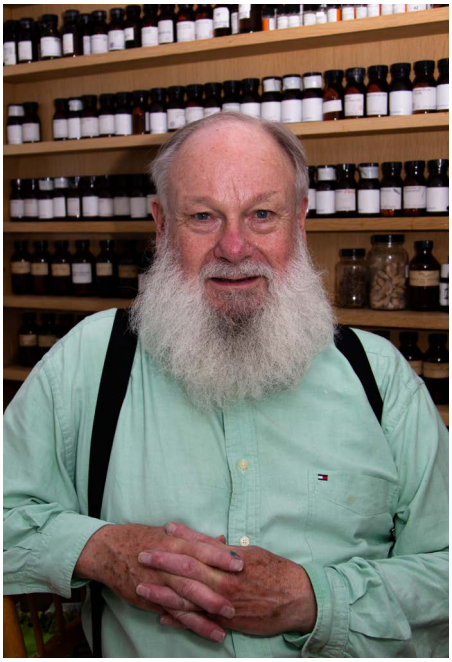
Flavour Pathway

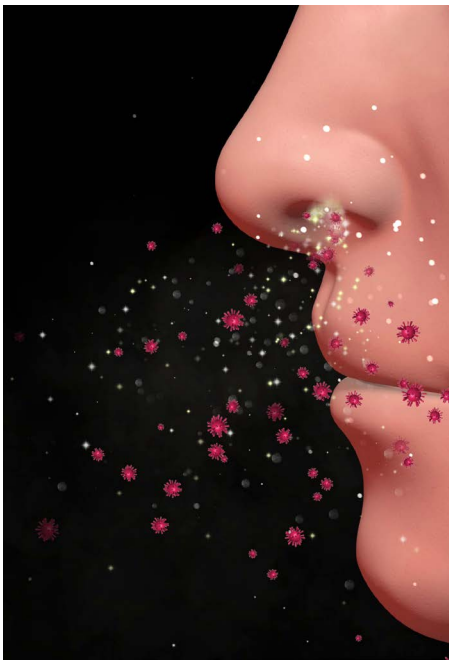
4 Flavour Creation and Evaluation
5 Application of Flavouring Materials in Flavoured Products

Fragrance Pathway

4 Fragrance Creation and Evaluation
5 Application of Aroma Materials in Fragranced Products

IN THE NEWS





Dr Tony Curtis

ICATS Founder and Principal Tutor

A recent BBC World Service programme featured the 1,000 year social history of glasses. By the 20th century there was fair understanding of sight and sound. We had glasses to correct defects in our vision and had an appreciation of the nature of colour blindness. A deep philosophical question is 'What is truth?' I will use a very simple definition: it is what appears to be true. Thus how we perceive the universe though our five senses is both a scientific and philosophic issue. A recent press release from Nobelförsamlingen (The Nobel Assembly at Krolinaka Institute) announced the award of 2021 Prize for in Physiology or Medicine jointly to David Julius and Ardem Patapoutian for their discoveries of receptors for temperature and touch. The press release started with a discussion of the work of René Descartes (17th century philosopher) posing the philosophical (and scientific) question of how we perceive heat. It is taking some time for us to get an answer!

Time and time again we invite our ICATS Newsletter subscribers to read around the subject. Here is why. There is nothing to suggest in this award title that this has anything to do with food and flavours. Wrong! The question (we focus on the work of David Julius at the University of California) is how do we convert heat to an electrical signal that can be processed by the brain to a sensation hot? The experiments were not conducted with red-hot needles on single nerve receptor but using chemical stimuli. Chilli peppers to the rescue with capsaicin. They used the knowledge that the receptors that responded to hot also responded to capsaicin with a signal hot. Well we now know that hot is signalled by a receptor (TRPV1). Both David Jules and Ardem Patapoutian also identified a receptor (TRPM8) which responds to cold. Here mint (well menthol!) was the tool used in the investigation.

The 2004 Nobel Prize for in Physiology or Medicine was awarded jointly to Richard Axel and Linda Buck for 'Discoveries of odorant receptors and the organisation of the olfactory system.' The 21st century is now advancing our knowledge of odour and flavour perception. Topics that have intrigued and challenged philosophers (and scientists) since the 17th century (and before) are now slowly being understood.

A recurrent theme in the IFRA UK Fragrance Forum is the clinical aspects of odour. *Olfaction: A Journey (Celebrating a decade of the IFRA UK Fragrance Forum)* was reviewed in the last edition of the Newsletter. The September 2021 edition of *Chemistry World* had this topic as a feature article: *The Doctor Will Smell You Now.* The author Ian Le Guillou found that diagnosis by odour is nothing to be sniffed at. In this article a retired nurse Joy Milne's ability to smell Parkinson's disease was reported. For some 40 years GC /MS has been linked to

Rachel Carson (1907-1964), biologist and writer, holding her ground breaking book, The Silent Spring, 1963

an odour port. Here a trained nose smells the GC effluent and an odour description can be written against each part of the GC trace. The MS aspect of course allows the identification of the components. The technique was of great value in understanding the major contributors to the odour profiles of essential oils. A major peak may make little contribution but a trace of a pyrazine may be a major odour contributor. The theory is that healthy people give off volatile metabolites. Specific diseases may introduce different volatile metabolites. If you can identify these then you have a potential non-invasive form of diagnosis. One attraction of this is that it can be a safe form of screening for people with potential risk factors and provide early diagnosis.

If the above was of special interest to us in the Aroma trades, the more general burning topic is global warming and society's need to reduce and mitigate the danger. As this column is being written the Glasgow UN COP26 conference on global warming is due to start. As you read this you will know the outcome and if we are to be more or less hopeful about the future from these deliberations.

In the run into the conference the press, TV and radio have been awash with programmes and articles on the issues. Dr Green reviews some discussions that have taken place within our industry in this newsletter. A BBC World Service programme opted to explore the early history of the science. What was depressing was the PR activity of some vested interests to discredit and obscure this scientific work because of the economic impact on global energy industries. A little while ago we reviewed the seminal book *Silent Spring* by Rachel Carson (1962)[1] which arguably is the foundation of the green movement. She too was subjected to a flood of negative briefing by vested interests. Early work on the link of smoking and premature death was also subject to extensive adverse briefing. Here I remind readers to always apply the reality tests when reading reports and papers on controversial subjects where powerful lobby interests are involved. We reviewed David Spiegelhalter's *The Art of Statistics: Learning from Data* last year and his rules are:

- Why am I hearing this number? Be sceptical of the motivation of the person giving the number.
- Are they trying to make it big or small?
- Are they trying to persuade me rather than inform me? (Too often it is the former!)

The subsidiary questions are: -

- Can I believe this number?
- Where does it come from?
- Does it actually represent what I think it represents?

His explanation is *'It is a bit like judging [sniffing out!] fake news'*. You must always evaluate the context of a figure since a number without context is meaningless. Apart from the host of nations with conflicting agendas there is an army of PR folk and lobbyists peddling their employer's specific interests. It is no easy task to pick a way though this minefield of information and disinformation. Let us hope we end up with a framework that will not allow the nations to slide to catastrophe. The world will survive global warming (just as it survived the ice ages) but mankind may not!

It is nice to end this column on a positive high note. We congratulate Holly King (featured in this edition of the Newsletter) on her IFEAT Diploma success. Her dissertation topic was on *'What consumers want from a hand hygiene product: from the fragrance, packaging and whole sensory experience.'* This is a fine example of how ICATS students' work is related to their employer's context providing value to their organisation.

[1] Silent Spring was first published in 1962. The book is still in print. It is considered one of the 25 greatest science books of all time. It overcame a torrent of opposition from vested interests and led to a ban in the USA of DDT for agricultural use. The green movement was underway!

MEET THE STUDENT

Holly King

I never knew the world of perfumery existed until five years ago when I had just completed my degree in forensic science, initially looking for a job in that area, but was unsuccessful. However, I then started to look for jobs in any chemistry-based company and accepted a job working as a perfumery lab technician at a fragrance house called Seven Scent Limited (PZ Cussons). PZ Cussons manufacture personal wash products for brands like *Carex* (which you probably would have used a lot of through the pandemic), *Imperial Leather, Original Source*, and many others. After about 1 ½ years of compounding fragrances and smelling raw materials daily, I realised that I had really found an interest in many aspects of perfumery and would like to pursue a career in this industry. I specifically had an interest in fragrance evaluation, so I started training with my manager who is a senior fragrance evaluator. My job became much more exciting as time went on, as I started to understand more about how to describe fragrances, how to interpret fragrance briefs, how to conduct sensory fragrance panels and most importantly building my olfactive knowledge of products around the world.

In March 2017 I was given the opportunity to attend the British Society of Perfumers workshop weekend at Hotel Football, Old Trafford in Manchester. I got the chance to work on a fragrance brief, with the assistance of a fragrance evaluator, for the interpreting the brief and a perfumer to help with the creation aspect. In this moment I realised my passion for fragrance and I knew I wanted to continue my journey in perfumery.

The workshop weekend was an amazing experience for me, still learning and finding my feet. I met many other people in the industry, which gave me an insight into how big the industry is and all the paths of perfumery that I could pursue in the future. After attending this, I was made aware of the ICATS/ IFEAT course and how well recognised it is in the perfumery industry. I then requested to study the course as I believed it would give me the perfect stepping stones to enhance my knowledge of fragrance, all while still doing my full-time job.

As I started the ICATS course I didn't really know what I was getting myself into; it was a lot more difficult than I originally thought it would be. However, once I finished the first module I really got into a routine. I booked specific time in my calendar to study, mainly Friday afternoons as this was time I could stay after work undisturbed and focus on the course. Working in a fragrance house helped me a lot with understanding certain modules and I could apply many of the activities to my daily job role. The fact that perfumers and evaluators were available to speak to for advice and help with my diploma was a huge relief. As they have so much experience in the industry, they could give me different perspectives on how to train my nose and how to recognise certain notes and raw materials. For example, there is material called Nonadienal which has a very green, fatty, cucumber scent. I don't particularly like the smell of this material, as I perceive it to smell very fatty and dirty, I described it as 'a dirty cucumber that has been stomped in the mud'. Even though this description is not how it should be described, it really helped me remember the material. In realising what types of smells I didn't like I always noticed what types of smells I loved! Musk is one of my favourites as I think it can give a fragrance a comforting feel and it makes me feel warm inside.

When the Covid-19 pandemic hit the UK in March 2020, I was three quarters of the way through my Diploma and for a few months I wasn't as engaged and didn't always study

Sharon Shand of ICATS (left) meets Holly King at the Royal Institution

when I planned to. However, other things became a priority like my mental wellbeing and work became a lot more demanding, as a few of us in the team at work had to cover for staff that were off due to isolating and being vulnerable, etc. so, when I did arrive home after work, I was so tired I felt like my brain was not in the right mind to work on my diploma. May came around very quickly and I managed to get back on track with my studies and powered through. Some days I got to work from home, so I managed to get a lot of my research and reading done then. For me the most difficult part of the Diploma was module 13 (dissertation), as this piece of work was the most important and I wanted to show how much knowledge I had gained in the past two years I had been studying. But also apply some of the experience I gained from my job role at PZ Cussons.

Consequently, I thought it would be very relevant to research hand sanitizers and explore what consumers want from a hand hygiene product. From the fragrance (or not) to the packaging itself and the whole sensory experience of the product. Initially I did want to approach consumers in the street, however in the situation at the time, it was not feasible or safe. Thus, I decided to use PZ Cussons employees and two other fragrance houses to assist with the collection of questionnaire data to support my research. It took me two months to collate and analyse 199 sets of data, which was a nightmare. It was such a relief when it was done. I think I must now be an expert on using Microsoft Excel!

I was finally coming to the end of my dissertation in May/June 2021 and colleagues and friends helped me proofread my work for a month and I then submitted the 12,000 word piece of work in July. I felt so relieved when I pressed send on my email, my hand was shaking at the time. I think I just was so scared of submitting the final piece of work after such a long time of studying the Diploma. I hoped that I had done enough to make my tutor (Dr Tony Curtis) proud and also the rest of my team at work who had helped me along the way.

Overall, the whole experience doing the Diploma was amazing, and I wouldn't change it for the world. I am just now so glad I have completed it and I am getting closer and closer to becoming a fragrance evaluator.

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There is no doubt that the planet is facing a number of crises: from climate change and weird/dangerous weather patterns to air pollution and ocean plastics not to mention habitat loss due to industrialisation. Is it going to be resolved if we reduce consumption, reuse items, and recycle those we can't both at home and at work?

Dr Ali Green

GREEN CHEMISTRY

A discussion provoked by the Green Chemistry Masterclass by John Warner at IFRA 2021

Surely the virtuous warm feeling I get when re-using a plastic ice cream tub to store batch-cooked spaghetti sauce in the freezer or dutifully put out the fortnightly recycling for the local refuse team to pick up is justified? If enough people were to do the same, won't all these issues of plastic and air pollution along with climate change resolve themselves? Well, the short answer according to John Warner is an emphatic no! It definitely won't make things worse, but (and it's a big BUT) unless green chemistry techniques and strategies are employed across the entire manufacturing processes, things will inevitably be unsustainable. So the big question is what can we, in industry do about this major global problem? Well, just as the genius of Chemistry has created many of the processes and products we know to be problematic, it too can solve many of the problems by rethinking the process of new product development and manufacturing using nature as its template.

Firstly, it's important to understand why the current policies of most governments and industries of 'reduce, reuse and recycle' won't create a stable and sustainable system. John explained this very neatly with an excellent diagram explaining current processes, which I summarise here using a step-by-step process.

1. Natural resources are subjected to extraction processes
2. The extraction processes give us molecules and ingredients which are then synthesised
3. The synthesis gives us materials and components which are then manufactured
4. The manufacturing creates finished products

Now, according to the 're-use' element of standard eco policy, we should try to remain at 4 for as long as possible with a product, repairing if necessary. However, we all know, particularly with one shot plastics this can't always be the case. Plus, every product will eventually be rendered

unusable due to the inevitability of entropy*, even my faithful ice cream tubs that have been washed and re-used numerous times. For some products this will be a really long process, whereas for others it may happen after a relatively short time. The adoption of built-in obsolescence or product failure as a manufacturing strategy to ensure more sales has accelerated this unnecessarily in many areas of manufacturing: products are not created to last!

Once entropy occurs, the products have to be broken down into components using mechanical or chemical recycling strategies (nearly all of which use energy) so we are back to stage 3 again. This will form a neat manufacturing and recycling loop for a while until, yet again, the inevitable entropy comes into play meaning recycling is no longer an option, meaning that these damaged components will have to be subjected to molecular reprocessing, returning us to stage 2 once again. Stage 2 can also maintain a stable system for some time for some components but will, like stage 3 and 4 also inevitably fail.

In order to get back to natural resources at the beginning of stage 1, however, we have what can be a lengthy process of degradation. In fact anything that ends up in landfill at the end of stage 4 without being reused or recycled, will also be subject to degradation. It is at this stage that we often see environmental leaching and pollution.

Thus by adopting traditional chemical manufacturing strategies and widely adopted sustainability policies, John bluntly says we are going against nature itself. By moving from 1 to 4 using very clever but unnatural methods to achieve goals we are setting up a pendulum effect rather than a closed loop since nature will always follow the laws of physics (notably entropy) and move from 4 down to 1. This is where green chemistry techniques come in – it is an opportunity to examine what techniques create a sustainable system in nature and mimic that in order to produce exciting new products. The trouble is here that chemists have been taught to break chemical bonds using heat, current or strong solvents (let's face it, this is a challenge and also quite satisfying): new functional groups are added on to artificially created molecules in order to develop a multi-functional, but often inherently unstable molecule, that satisfies all requirements in the brief but naturally wants to split so requires some form of chemical/physical coercion to remain and do its job. Many geniuses of the Chemistry world have created some incredibly complex and clever products and processes that are used worldwide. Now, however, an urgent revision is needed as we fully realise the impact of these brilliant processes on the planet and its natural ecosystems.

* This web page has an excellent definition of entropy that is ideal for those unfamiliar with the concept: - https://heinenhopman.com/en/about-us/blogs/20200625_what-is-entropy-part-1-a-simple-definition/

John believes that education is the key here, going right back to high school chemistry, through university to graduate school, with 12 basic principles of green chemistry taught alongside curriculum staples.

1. **Prevention:** It is better to prevent waste that to treat or clean up waste after it is formed
2. **Atom Economy:** Synthetic methods should be designed to maximise the incorporation of all materials used in the process into the final product
3. **Less Hazardous Chemical Synthesis:** Whenever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment
4. **Designing Safer Chemicals:** Chemical products should be designed to preserve efficacy of function while reducing toxicity
5. **Safer Solvents and Auxiliaries:** The use of auxiliary substances (solvents, separation agents etc.) should be made unnecessary whenever possible and, when used, innocuous
6. **Design for Energy Efficiency:** Energy requirements should be recognised for their environmental and economic impacts and should be minimised. Synthetic methods should be conducted at an ambient temperature and pressure
7. **Use of Renewable Feedstocks:** A raw material or feedstock should be renewable rather than depleting whenever technically and economically practical.
8. **Reduce Derivatives:** Unnecessary derivatisation (blocking group, protection/deprotection, temporary modification of physical/ chemical processes) should be avoided whenever possible.
9. **Catalysis:** Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. **Design for Degradation:** Chemical products should be designed so that at the end of their function they don't persist in the environment and instead break down into innocuous degradation products
11. **Real-time Analysis for Pollution Prevention:** Analytical methodologies need to be further developed to allow for real-time in-process monitoring and control prior to the formation of hazardous substances
12. **Inherently Safer Chemistry for Accident Prevention:** Substance and the form of a substance used in a chemical process should be chosen to minimise the potential for chemical accidents, including releases, explosions and fires.

(https://www.acs.org/content/acs/en/greenchemistry/principles/12-principles-of-green-chemistry.html)

These principles are not intended to clip the wings of creative chemists. Rather they should be viewed as a new challenge for chemists to rise to and create or discover some brilliant new molecules that could revolutionise industry for the future. For John, the key is to observe what happens in nature. For many of us, this can most easily be seen in our own bodies and the complex chemistry that occurs within the various systems such as the gastrointestinal tract and the circulatory and nervous systems.

In this regard, there are five key concepts found throughout nature that John believes should form an integral part of any entrepreneurial venture in chemistry: -

A. **Triggered Change** – in nature things aren't only on or off permanently, rather they are on when needed and off when not e.g. hearing neurones (only triggered by the vibrations of sound) and gastric juices (only triggered when something that isn't our own bodies is present)
B. **Collaboration** – rather than adding on functional groups so that one molecule does everything, nature has numerous molecules working collaboratively and reciprocally e.g. in the digestive tract there is a multitude of different molecules along with bacteria and some yeasts to break down your lunch

C. **Alignment** – there is almost never a reactive collision using heat or pressure in nature. Nearly every action in biology happens in a semi-viscous watery environment with subtle diffusion and transitions rather than fast dramatic ones e.g. Oxygen transfer in your blood.

D. **Synchronicity** – in chemistry we are taught there are two distinct stages: materials undergo a reaction and create a desired product. However, in nature cells undergo thousands of reactions simultaneously rather than one at a time. When examining such reactions and transformations, it's vital to understand the nature of the changes, some of which are reversible and some irreversible, but all happen simultaneously and in harmony with one another.

E. **Diversity** – there has been a tendency to aim for high purity-based systems in chemistry and this is much easier to attain (and therefore also cheaper) with synthetics rather than biobased materials. However, nature hardly ever bases its systems on high purity; it actually thrives on molecular diversity as this will enable more resilience and adaptation for things like temperature or pH variation. If we can mimic this natural mixture approach, separation is not always necessary to achieve the same end – a highly lucrative prospect both financially and environmentally.

So how will chemists be able to move towards greener strategies? Certainly education is needed. John Warner helped to found Beyond Benign – an organisation that pioneers green chemistry resources for educators from high school through university to work-based learning. You can find lots of really helpful information, links and learning material on their site https://www.beyondbenign.org/

The materials on offer include open access curriculum guidance, experiments for students and much more – well worth checking out! There are also a multitude of textbooks available with one of the first *Green Chemistry, Theory and Practice* by Paul T Anastas and John C Warner published over 20 years ago by Oxford University Press US (ISBN 978-0-19-850698-0). It is a concise but excellent resource despite its age. More recently, the third edition of *Green Chemistry: An Introductory Text* by Mike Lancaster and published by the Royal Society of Chemistry in 2016 (ISBN 978-1-78262-294-9) provides a detailed overview of all chemical processes with extra detail on 'problem areas'. The chapter headings are: -

1. Principles and Concepts of Green Chemistry
2. Waste: Production, Problems and Prevention
3. Measuring and Controlling Environmental Performance
4. Catalysis and Green Chemistry
5. Organic Solvents: Environmentally Benign Solutions
6. Renewable Resources
7. Emerging Greener Technologies and Alternative Energy Sources
8. Designing Greener Processes
9. Industrial Case Studies
10. The Future is Green: An Integrated Approach to a Greener Chemical Industry

Both excellent publications contain a number of case studies. Sadly none of these are directly related to the aroma trades, but their relationship to practices within our industry are clear, particularly the section on pesticides in Lancaster.

It was heartening to attend a BSP event online in June, the first of a series putting the spotlight on responses to green issues in the industry, that explored what Firmenich were doing to address sustainability and the environment. This is written up in detail in this Newsletter. Please see the BSP website for details of further events. John Warner is also booked to speak at the upcoming online IFEAT Conference in November where there will also be a wealth of other excellent speakers. Please see the IFEAT website for details.

So, chemists – get inventing! The future of the planet is in your hands!! In the meantime, I will continue to do my bit by attempting to defy entropy by reusing my plastic tubs for as long as possible and putting out my recycling each week for my local council to hopefully process with as little environmental impact as possible.

Review of BSP lecture Digitalising the Sense of Smell by Alex Wiltschko and BSF lecture Modern Strategies and Techniques of Analysis of the Volatile Fraction as a Tool for Food Control and Characterisation by Carlo Bianchi

Dr Ali Green

Analysis, AI and the Aroma Trades – what does the future hold?

I had the pleasure of attending two fascinating online lectures in May, one from the British Society of Perfumers that investigated if AI could be used to develop some kind of artificial smelling tool or 'osmoscope' and the second exploring how food chemistry, analytical techniques & large data sets in the field of metabolomics (the study of metabolites) could be used to assess quality of specific flavour ingredients. Both speakers discussed science (and some maths) that was mind-blowingly complex (at least for me!) so I will not be attempting to replicate the details here, rather I will attempt to give an overview and then provide links to academic publications that will provide the details for those who would like to explore this ground-breaking field in more depth.

Alex Wiltschko of Google Brain shared some of the research his team have been working on exploring machine learning for olfaction. Initially he wanted to ensure that novices (like me) were able to grasp the meaning of key terms like artificial intelligence (AI) and machine learning (ML): there is no agreed definition of AI but most AI applications are based on ML defined as 'techniques that let software learn behaviour from example data rather than rules defined by the programmer'. The four main techniques of ML are: -

- Classification
- Prediction
- Generation
- Language understanding

These are usually employed as part of a problem-solving strategy and are in use across numerous fields from agriculture to healthcare. Success in ML depends upon several key factors: good data, good tools and sound research, trained people and centralised resources (since it can be prohibitively expensive to do all the jobs in house). The latest research on effective ML shows that smaller data sets prove more accurate than large ones (although this is not always possible in some fields of research that have a wider scope) and very specific and clear use of language that avoids ambiguities and muddy thinking. It's important to remember that ML is always a collaboration between algorithms[1] and humans. When ML is employed effectively, it has proved invaluable in machine perception (robots/machines with video and audio recognition e.g. computerised pathology analysis in medicine), generative models (computerised predictions used widely in the financial sector) and unsupervised and reinforcement learning.

It would be tempting to assume that we could approach digitalising the sense of smell in the same way that computerised vision and audio capabilities have been developed. However, more than 200 years of research lies behind recent developments with the senses of sight and hearing being pretty much understood by the middle of the last century with early vision and audio theories going right back to Aristotle and the Greek Atomist philosophers! Understanding of the senses of smell and taste has been far more elusive and challenging, with a number of theories still being explored. It is fair to say that one of the main reasons that this is a challenge is that, unlike the science of sight, where photons and their interaction with the eye is fully grasped and can therefore be replicated in a machine, the interaction between scent and taste molecules and our olfactory system is only beginning to be understood. There does not seem to be an obvious relation between molecular structure and aroma that could be plugged into a digital device along the lines of "if it has a specific functional group, it will always smell of lilies" since similar molecules don't always smell the same and disparate ones sometimes do! The mysteries of aroma chemistry therefore make this more of a challenge for those wanting to develop an 'osmoscope'.

The team at google brain were determined to discover some kind of pattern in the data and so painstakingly recorded the structural features and aroma qualities of 5000 molecules. They recorded these on a graph neural network (GNN)[2]** to see if there were any meaningful correlations between structure and aroma[3]. Inside the NN, around 60 dimensional embeddings were organised intuitively into separate categories that fitted into broad

odour descriptors – this at some times seems to reflect the molecule structure but not always, as some families of molecules were distributed across numerous activity centres. An interesting question is thus why are they forming these GNN patterns since nature doesn't generally evolve in a purely random way, there must be some kind of perhaps evolutionary need or reason. What is clear is that this reason cannot be nutritional because nearly all molecules of nutritional value are odourless apart from short-chain fatty acids which actually smell rancid! Although there are undoubted therapeutic qualities for some of nature's fragrant plants such as lavender, many other 'useful' plants have no scent at all like *plantago lanceolata* (ribwort plantain). So what is going on?

The Google Brain team have posited that olfaction has evolved to detect the chemical processes that create or result from the molecules that affect our survival and are correlated to positions in the carbon cycle. The plots on the GNN appear to correlate to fruiting photosynthesis (grape family), flowering photosynthesis (lily family), animal respiration (musk family), combustion (toasted family), putrefaction and decay (mushroom family) and fermentation (rum family). The hypothesis then examined various aromas and what they might signal to a sentient being:

- Rotting meat in itself doesn't make us sick – it's the enterotoxins the putrefying bacteria secrete in the gut. Thus, decarboxylation of amino acids into compounds charmingly named putrescine and cadaverine only create a revolting but harmless smell.
- The smell of baking bread or cooking meat from Mallard reaction products doesn't in itself feed us, rather it signals the carbohydrates and amino acid precursors.
- Smells of specific places are absolutely vital to survival – ocean is not fruit, forest fire is not rot and meat isn't dirt!

So, does this interesting theory and the research of the Google Brain team bring us any closer to an 'osmoscope'? The answer is tantalisingly perhaps, but it is unlikely to be in the near future. What is clear is that if smell could be digitalised, it would bring numerous benefits to society across numerous fields – from healthcare to the environment as well as industry applications associated with QC, formulation and fragrance creation.

Alex was keen to hear from anyone in the industry who would like to contribute or comment on the team's research. He can be reached on alexbw@google.com

He also highlighted a new publication on Interpretability in Chemistry by the team: -

Sanches-Lengeling, Benjamin et al., 2020, Evaluating Attribution for Graph Neural Networks, *Advances in Neural Information Processing 33 2020*

The British Society of Flavourists brought in expert Food Chemist Carlo Bicchi of Turin University's Laboratory of Pharmaceutical Biology and Food Chemistry to discuss his team's ground-breaking work on the sense of taste and how this could be digitalised. Carlo first discussed the situation in the recent past, highlighting how there had been a traditional gap in attitude towards the sensory skills traditionally employed by perfumers (viewed by scientists as a more fluid/creative approach and thus imprecise) and the use of analytical chemistry (viewed by perfumers as rigid and unable to equal the olfactory capabilities of a living being).

In order to explain how the new union of chemistry and biology known as sensomics is helping to pioneer a new approach in flavour quality control, Carlo began with a few definitions. When examining a volatile fraction[4] analytically the first thing to note is that each fraction has a different and mutually non-comparable composition to others. each comprising its own headspace, essential oils, aromas[5], flavours[6], fragrances[7] and extracts. A new approach, part of the field known as metabolomics, examines metabolite[8] fingerprints from specific cellular processes: according to Carlo

"the goal is a comprehensive and quantitative analysis of the largest possible array of low-molecular weight metabolites" in biological samples. Within metabolomics, there is a subdivision that focuses solely on sensory studies known as sensomics which heralds a new and far more effective kind of analysis combining fingerprinting and profiling. Between sensomics and chemical analysis lies the new field of sensometrics, which *"tries to establish relationships between the sensory scores of a food aroma and its chemical fingerprint or profile with chemometric tools"*. The aim is a Total Analysis System (T.A.S.) linking sample preparation, analysis (separation and detection) and data elaboration (chemometrics) into one process. This is encapsulated in sensomics, a process described by Carlo as "a gold standard for food sensory characterisation". It has five components: -

1. Isolation: using the SAFE process (solvent-assisted flavour extraction)
2. Screening: using AEDA tech (aroma extract dilution analysis)
3. Identification: ITs, MS spectra, odour
4. Quantitation: using SIDA (stable isotope dilution analysis)
5. OAV measure/flavour reconstruction (detecting the odour activation value - the amount at which it is detected by the senses)

One food that Carlo's team has been working on using this technology is coffee with a view towards innovation in QC. They have isolated 32 chemicals responsible for the various odour profiles associated with ground roasted coffee and have assigned useful descriptors to each flavour molecule (such as 2,3-Pentandione: buttery or 3-Isopropyl-2-methoxypyrazine: earthy/roasty) and assessed the 'strength' of the flavour by assigning each a flavour dilution factor (FD factor)[9] and also its OAV to check if there's sufficient quantity to be perceived and thus contribute to the flavour profile. Different combinations of these are found in typical beans from specific locations thus creating the unique flavour profiles for different localities and the treatments they have received (whether they have been washed or not or given other treatments)[10]. A key element of their approach has been that it is solvent free, easy to automate, reliable and representative so that it is easy to replicate. The sensomic approach integrates both analytical chemistry and sensory evaluation to reach thorough conclusions that accurately describe the subtle differences between regional coffees both from their molecular composition and sensory qualities. Thus 'fresh' notes such as acid, flowery and fruity along with 'brown' notes such as bitter, nutty, woody and spicy can be mapped according to bean type and origin very securely because of their chemical composition as well as their sensory qualities. Far more details about this complex analysis and the specifics

of the chemistry can be seen in the papers detailed in the footnotes.

Carlo went on to discuss another important raw material that has been analysed in this way, cocoa, which is under pressure as a crop for a number of reasons: worldwide increase in demand and consumption and the impact of climate change on production, particularly the influence of rainfall and to some extent temperature and light conditions. A big problem in the processing of coca is the smoky 'off' flavour that can taint the end product (cocoa powder and chocolate) as a consequence of wood fires during drying and storage.Using the same approach as that used for coffee (a combination of HS-SPME-GCxGC-MS TOF analysis and sensory data) the team were able to detect a chemical 'signature' for the smoky and non-smoky samples that differed thus making it relatively straightforward to detect tainted crops at an early stage with a routine test. This means that what begins as incredibly complex chemical analysis can be translated to a routine quality control test using a far quicker mono-dimensional system with capacity for a high throughput that confirms the differences through phenolic and benzene derivatives.

Clearly the techniques discussed by Carlo are pioneering and can easily be transferred to other fragrance and flavour ingredients thereby aiding QC and ensuring trust and reducing capacity for adulteration or pollution within industry.

I would strongly recommend subscribing to the British Society of Flavourists' free publication the New Flavourist[11] and follow their Twitter feed for news on all flavour-related topics. The British Society of Perfumers[12] also have an active Twitter and Facebook feed; it's well worth checking out their events pages to join in online and in-person sessions that provide access to industry experts talking on all manner of industry subjects.

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1 Algorithm definition: *"A mechanistic formula that will automatically produce an answer for each new case that comes along with no, or minimal, additional human intervention"* David Spiegelhalter The Art of Statistics (Reviewed by Tony Curtis for ICATS News in 2020)

2 Graph neural network definition: a neural network is a computing system that is based on the workings of an animal's brain using a system of nodes which replicate the neurones of a living creature. Neural networks with many layers have become known as deep-learning models. A graph neural network is a method of displaying complex NN data using a graph representation structure.

3 A detailed summary of this analysis and primary findings can be seen in this paper: https://www.semanticscholar.org/paper/Machine-Learning-for-Scent%3A-Learning-Generalizable-S%C3%A1nchez-Lengeling-Wei/19af82973b785c66c3033377eebca4513e106879

While this is Alex's blog summarising the paper in less detail: https://ai.googleblog.com/2019/10/learning-to-smell-using-deep-learning.html

4 Each volatile fraction is isolated from the overall matrix of a food material - it is a mixture of compounds released together at a specific temperature sometimes using specific solvents.

5 Aromas are usually volatile compounds consumed orthonasally and/or retronasally by the olfactory tissues in the nose

6 Flavour is the overall sensation provided by the interaction of odour and textural feeling when food is consumed.

7 Fragrances have a sweet/pleasant scent that derives from a non-food material and are orthonasally perceived,

8 Metabolites are the intermediate or end products of metabolism (chemical processes that happen within a living organism to maintain life)

9 The number of parts of solvent required to dilute the aroma extract until the aroma value is reduced to one.

10 Chemometric Modelling of Coffee Sensory Notes through Their Chemical Signatures: Potential and Limits in Defining an Analytical Tool for Quality Control, Davide Bressanello, Erica Liberto*, Chiara Cordero, Barbara Sgorbini, Patrizia Rubiolo, Gloria Pellegrino, Manuela R. Ruosi, and Carlo Bicchi,J., Agric. Food Chem. 2018, 66, 27, 7096–7109, Publication Date:June 12, 2018 https://doi.org/10.1021/acs.jafc.8b01340

E.Liberto, D. Bressanello, G. Strocci, C. Cordero, M.R. Ruosi, G. Pellegrino, C. Bicchi & B. Sgorbini, HS-SPME-MS-Enose coupled with chemometrics as an analytical decision maker to predict in-cup coffee sensory quality in routine controls: possibilities and limits, Molecules 2019, 24, 4515 https://doi.10.3390/molecules24244515

11 You can subscribe here: https://www.bsf.org.uk/

12 https://bsp.org.uk/

EVENT REPORT

This was the first of a series of talks organised by the BSP on green chemistry and sustainability highlighting steps the industry is taking to ensure a promising future for the planet and its inhabitants.

Review by **Dr Ali Green**

Ambitions and Future Ingredients – a BSP talk by Julien Firmenich

Firmenich, a family firm founded in 1895, is one of the oldest f & f businesses in the industry. Julien feels that they maintain a "long-held legacy of responsible business and consciousness of doing the right thing to ensure a positive future for all." He then outlined the various elements of the Firmenich's strategy going forward that they hope will make a significant impact on sustainability and provide templates that can be implemented by other businesses in the aroma trades.

Use of white biotechnology in the development of novel aroma chemicals

White biotechnology uses living organisms like yeasts, bacteria or enzymes in production processes to reduce the energy required in manufacturing and also to make these products easier to dispose of with less/no environmental impact. Obviously, this kind of process has been used for many thousands of years in industries like brewing but bringing it into to other industries like the fragrance industry is relatively new. Julien highlighted Z11 Ambrox™ (which derives from sugar cane) and Dreamwood™ which have recently been developed using white biotechnology.

Membership of organisations innovating in climate change and social impact of industry

Firmenich has joined forces with numerous organisations to improve practice within the company and promote good practice in industry. Notably, they are industry leaders in a number of fields and received several accolades in recognition of this including being in top in the industry for the 2021 Financial Times Europe's Climate Leaders listing

Sustainability in product development

Having recently acquired DRT, Firmenich have pooled their resources to embark on four new product development platforms that it hopes will be standard by 2030: -

Sylvergreen™ – concerned with renewable carbon not only for new products but also converting existing ones. This has also involved working with partners to assist them in producing ingredients from upcycled materials.

Green Gate™ - driven by green chemistry principles, this initiative is all about working towards biodegradability in the industry across the entire extraction and manufacturing process (aiming to be higher than 95%). It goes way further than current legislation with a view to the future.

Naturals Together™ – focus on responsible sourcing of naturals and traceability through the Path2Farm™ initiative embracing new partnerships that also champion gender equality, education, human rights and a living wage. Another aspect to this strategy is a focus on extraction methods using the Firgood™ solvent-free process that is also green in terms of water/waste. Innovation here has led to new F&F ingredients such as new green bell pepper, ginger and pear products.

Active Circle™ – this strand of the strategy is concerned with renewable ingredients that are made from by-products and bio-based ingredients

One challenge is that there is a price implication in embracing these new initiatives and work on how the products will be sold to consumers at a higher price will need to be done. It is vital that the public is convinced that the industry is not simply 'greenwashing' but has actually embraced green principles and taken on board the ethics of partner companies and how workers are treated. There are some F&F notes (many widely used and irreplaceable) that cannot at present be produced sustainably so the industry must consider how it deals with this tricky situation and work together for solutions.

Further details on the initiatives outlined in the talk can be found here on the company website: https://www.firmenich.com/company/sustainability

International Fragrance Association
IFRA UK Fragrance Forum 2021

Deirdre Makepeace and **Sharon Shand**

Hidden Depths: Memory, language and the sense of place.

The day was introduced by IFRA UK Director, Lisa Hipgrave, and delegates were welcomed to London's Royal Institution, home of the famous Christmas lectures. The contemporary theme of 'Hidden Depths' recognises the value of scent in our changing lives and the devastating effects of scent loss.

Proceedings were chaired by Professor Barry C. Smith the founding Director of the University of London's Centre for the Study of the Senses. He works on the multisensory nature of perceptual experience, taste, smell and flavour. In introducing the session he stated that 65% of Covid suffers will experience a smell or taste disorder and that 10% will suffer long term. Loss of smell was not initially understood as an early marker for Covid-19 but it is now considered as one of the best indicators for the virus. Patients can describe this loss as 'fundamentally not in touch with the world around them' stating for example, 'I feel discombobulated...like I don't exist.' In other words patients suffering from loss of taste and smell can experience a profound shift in the way that they feel about themselves.

The terminology surrounding this loss is becoming more familiar to us and it may be helpful to consider the definitions:

- Anosmia – the temporary or permanent loss or impairment of the sense of smell where people have no sense of smell or are unable to smell certain things
- Parosmia – the condition where patients have a distorted sense of smell, for example common foods may smell disgusting
- Hyposmia – a reduced sense of smell
- Phantosmia – where patients sense odours (usually bad ones) that aren't there.

These are all terms that are becoming used more since the pandemic and particularly by those experiencing 'long-covid' symptoms. For any of these conditions the causes can be complex and they can be markers for wider medical issues. Through recovery some patients can find that smells become distorted, revolting or disgusting, with coffee, mint, meat and onion stated as examples that can elicit very negative perceived scents. Nice smells can become nasty and nasty smells nice. Barry confirmed a fact reported in a previous edition of ICATS News: 'A consistent finding is that poo smells great!' In summary Barry stated that: 'we have learned just how important our sense of smell is'.

Mr Peter Andrews is the Senior Consultant Surgeon in Rhinology and Facial Plastic Surgery at the Royal National ENT and Eastman Dental Hospital, Consultant Anterior Skull Base Surgeon at the National Hospital for Neurology and Neurosurgery and the Associate Professor of Rhinology at University College London. He is now beginning to work with long-covid patients for whom the passing of time and participation in smell training has not resulted in recovery of the sense of smell. The potential of surgical solutions is now being explored for such patients. Defining the problem is challenging with some subjectivity but the universally used measure of Sniffin' Sticks test (Burghardt®) can be supported by the more objective findings of structural and functional MRI scans.

There are thought to be 5.2 million cases of covid-related smell loss in the UK and the science surrounding recovery is still emerging. The data gathering has been tremendously supported by the work of charities Fifth Sense and Absent, whose Covid-19 Smell and Taste Loss Facebook page has over 32,000 members.

Surgery has historically been known to result in improvements and Peter shared the well-known case of a patient he treated with surgery for snoring who recovered his sense of smell after 40 years, having lost it after a cricket accident. Improvements post-surgery for covid patients could be as a result of a number of factors including improved airways and nasal stimulation, better aeration or it could be that the surgical trauma kick-starts the regenerative process. Platelet Rich Plasma is also being studied and trialled as a means of supporting regeneration. There are however a number of key steps before surgery would be considered including smell training, steroid treatment and cessation of smoking.

Artist: Omer Polak,
Photo by Shakupa&Stark

There is also a female bias in that, although males and females have the same number of olfactory receptors, there is a female bias in referrals as a result of what Peter describes as females' more 'exquisite' sense of smell. Resourcing is of course a significant issue as this new area of surgery gains importance.

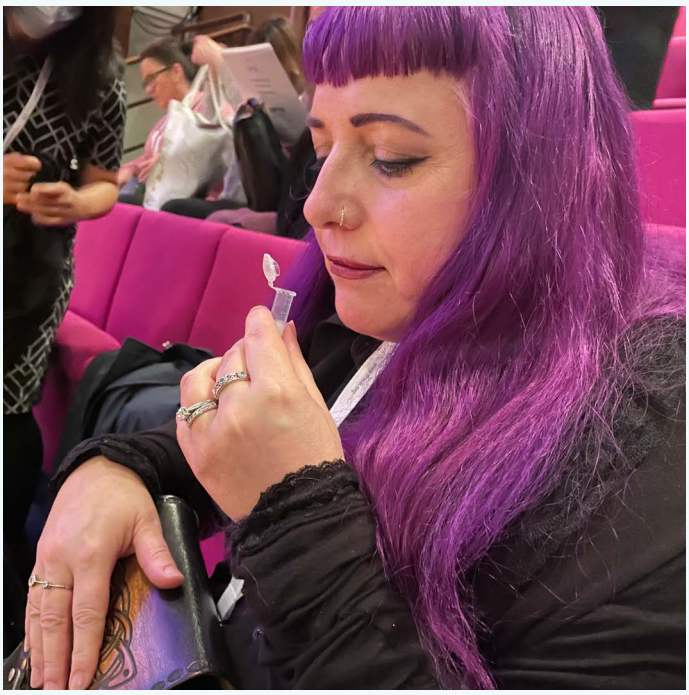
Moving far from the world of surgery, delegates then heard from Omer Polak, of Studio Omer Polak in Berlin. Omer is an artist and sensory designer and an introduction to his approach to the senses can be viewed at his TEDx Lausanne talk in which he creatively explores how design innovation and neuroscience can offer a new way to experience the world. His studio has developed a number of exhibitions and installations that explore scent as a design tool. A white cube at Trapholt, a museum of contemporary art and design in Denmark in which Omer's studio created an olfactory forest; a synthetic and clinical environment where visitors could discover forest smells and sounds, prompting discussions around individual wellbeing and the loss of forests. Delegates were 'transported' from the RI lecture hall to the forest with a sample of forest floor scent. Details of how the exhibit's scents were created can be seen at omerpolak.com/olfactoryforest

Professor Noam Sobel, Director for the National Center for Human Brain Imaging and Research at the Weizmann Institute in Israel, presented the very challenging concepts of 'a metric approach to Olfactory Space'. Sobel's research focuses on the complex nature and brain mechanisms of the human olfactory systems. His team has pioneered the development and construction of olfactometers, devices that precisely generate odours, and 'electronic noses' that mimic the animal nose in its ability to transform molecules to percepts. Noam quoted Alexander Graham Bell who said: 'Can you measure the difference between one kind of smell and another? It is very obvious that we have many different kinds of smells, all the way from the odour of violets and roses up to asafoetida. But until you can measure their likeness and differences you have no science of odour.' Noam is tackling exactly this challenge and presented research on the use of functional and structural MRI scans that are being used to measure neural activity and so record the percepts. He summarised the studies that show that we can predict the differences, making it possible to develop the technology to create smells. Think 'smellovision!'

Asifa Majid, Professor of Language, Communication and Cultural Cognition at the University of York presented a global view of olfactory language. Smell has been described as the 'mute sense', suffering from linguistic poverty making 'talking smells' especially difficult. For example, in 2014 Majid & Burenhult gathered descriptors of cinnamon which included the very varied ways of describing the spice as sweet, spicy, bayberry, candy, red hot, potpourri, wine, edible and smoky. She quoted wine columnist, Malcolm Gluck who has said: 'We wine writers are the worst qualified of critical experts. This is largely, though not exclusively, because we are the most poorly equipped. The most important tool at our disposal is inadequate for the job. That tool is the English language.'

Asifa referred to research stating that English perceptual language vocabulary has nearly 29,552 'modality exclusivity norms' for visual perception but only 216 for scents and that 'we don't talk about smell and when we do we are incorrect and inconsistent.' Although this is globally true there are some geographical differences and Asifa's research has included comparisons between Europeans and the Jahain, a rainforest tribe from Malaysia. Whilst facial expressions relating to smells may be universally similar the Jahain have a richer vocabulary for smells with no equivalent English words. Further research has shown some similarities in the way the bad smells have resulted in a clearing of the throat and some sounds pronounced at the back of the mouth for example with a glottal stop. Or disgust responses involving the lips such as blowing or spitting shaping words that feature in a variety of languages. Language takes olfaction from being the purview of the unconscious and forces it into consciousness, emphasising the significant skills of perfumers and evaluators in using the language of scents.

Dr Tom Mercer, Senior Lecturer in Psychology and Professor Sebastian Groes, Professor of English Literature at the University of Wolverhampton presented their cross-



disciplinary research into the roles of scent in identifying place; recalling memories and recognising the generally positive influences of childhood. Their work focused on the UK's Black Country and is progressing to a second phase in Romania.

IFRA UK announced news of a recently launched online resource, as part of an initiative formed by the 'Changing Lives Through Fragrance'. The interesting and eclectic website, www.fragrancematters.org is a rich new resource showcasing new research and quirky facts, whilst also listing organisations that can support people with smell loss or 'Anosmia' as it is known.

The day concluded with a practical wine tasting, led by Professor Barry C. Smith, with the influences of all of the senses being used to appreciate wine. Our perception of taste was demonstrably influenced by sight, smell and even the background music.

Top: IFRA panel discussion at the Royal Institution: Prof Sebastian Groes, Dr Tom Mercer, Prof Barry C. Smith, Prof Asifa Majid and Prof Noam Sobel.

Above Left: Sharon Shand (ICATS) sampling the fragrance of the forest captured by Studio Omer Polak

Above: IFRA wine tasting.

BOOK REVIEWS

Harold McGee
2020: John Murray, London
Hard Cover £35
ISBN 978 0 340 96322 7

NOSE DIVE: A Field Guide to the World's Smells

Reviewed: **Dr Tony Curtis**

This is another book where the title is slightly misleading. This comprehensive text may be a field guide but it is not a pocket field guide. Its 654 pages are packed with interesting thoughts on this enthralling topic.

In David Williams' discussion of the historical development of odour theory & language he starts off with two selected early examples of schemes for the classification of odours which have been put forward since the fourth century, B.C. These early attempts were aimed at considering the whole spectrum of odour (some good, some not so appealing!)

Aristotle (384-322 B.C.)
Classified smells into five categories: Sweet, Harsh, Astringent, Pungent, Rich

Linnaeus (Carl von Linné, 1756)
Linnaeus was the great Swedish botanist upon whose work the classification of animals and plants in use today is based. He suggested a scheme of odour classification based on seven categories: Aromatici (Aromatic), Fragrantes (Sweet-scented), Ambrosiaci (Ambrosial), Alliacei (Garlic-like), Hircini, (Goat-like), Tetri (Putrid) and Nauseosi (Nauseous).

I can relate to wet dog odour but I have not any memory of smelling goat! Most modern texts focus on the odour profiling of fragrances and flavours. This book does go the extra mile and considers the whole spectrum of odours. Ali in her excellent review of the Green Chemistry discussion brings attention to VOC (**V**olatile **O**rganic **C**ompounds). In the early days of the manufacture of aroma chemicals from CST (crude sulphate turpentine) the odour could be discerned for miles around the Jacksonville USA plant. Not so now, the EPA has regulated for the problem.

What is natural and what is un-natural. On page 71 Chapter 4 we explore the issue of factory farming. Intensive farming operations provide generous quantities of excrement from CAFOs (Concentrated Animal Feeding Operations) with odours that would make CST smell like roses.

However if this aspect of odour studies does not appeal to you we get onto more familiar ground in Chapter 8: *Plant Volatile Families*. I select one example of very useful tables (a particularly valuable feature of the book). On page 158/9 the table covers alcohols C1 to C8 (and corresponding acids) with a table: *Some alcohol – acid combinations – esters and their smells*. What is so useful about this is in a concise space; you get a lot of information and can see both the wood & the tees.

Fragrances are not neglected in this epic book: Chapters17 Fragrances, provides good succinct cover of this topic area: again, the wealth of tables provides much information about the materials considered (e.g., *some resins and gums used in incense and perfumes*, Page 445).

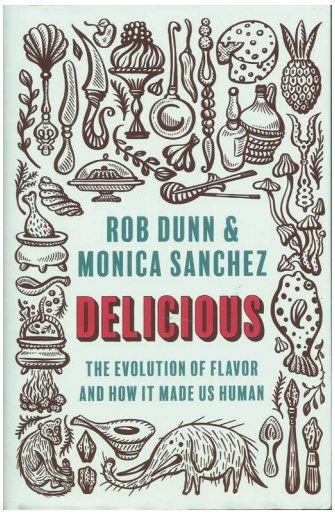
Flavours get their fair attention in two chapters 18: *Cooked Foods* and 19: *Cured and Fermented Foods:* again, a wealth of tables explores these aspects of odour/flavour. Here of course we have some different molecules such as *A Nutty Bouquet of Cooked Smells:* with pyrrolines, and pyrazines. Of course the sulphur compounds are not neglected with *A Sulphurous Bouquet of Cooked Smells*. Where would we be without methyl thioproponal and dimethyl sulphide, disulphide & trisulphide! The wide coverage and international orientation is continued with 19: Cured and Fermented Foods. We not only get cover of brandy and whisky, but also of other regional products such as Asian rice wines. Flavourists will also find this book of great interest.

In such an epic book it might be quite daunting to find one's way around; however, the indexing is excellent. If 654 pages are not enough to cover this topic there are 34 pages of detailed references. These take the reader from the individual chapters to a vast array of key papers and books.

Overall I am not certain this is a book for the individual student. However, it is an essential addition to the library of all organizations involved in the Aroma Trades. In that rare thing, a few hours of spare time, Creative Flavourists, Perfumers and all involved in new product development will find much to stimulate original thought.

Do get your organization to purchase a copy for the laboratory bookshelf and make certain you are the first to get to read it!

BOOK REVIEWS



Rob Dunn & Monica Sanchez
2021: Princeton University Press
Hard Cover £16.85
ISBN 978 0 691 19947 4

DELICIOUS: The Evolution of Flavour and How It Makes Us Human

Reviewed: **Dr Tony Curtis**

Just when you think that everything that can be written about food and flavours has been written, along comes a book with a completely new take on the subject. For me the key assertion is food is more than just fuel to keep us going. People and animals go to considerable lengths to access food that is not only nutritious but also a delight to eat: food that is delicious. I am reminded of a cat cartoon. The cat is looking at an advertisement which states '9 out of 10 cats prefer xxx cat food', the caption below states **'and I am not one of them!'.** Even cats can be picky eaters!

There is some sound coverage of the fundamental theory of flavour and odour e.g., discussion of the work by Linda Buck and Richard Axel (Nobel Prize winners) on the working of the olfactory receptors in the nose. Some of the consideration of animal and early man's appreciation of flavours is of necessity a little speculative.

In this review I will fast forward to Chapter 6: On the Origin of Spices. Again there is a bit of theory. Pepper contains piperine which fits the 'key' for the TRPV1 receptor. This is the same receptor that lets you know that that cup of coffee is just a bit too hot! Hot [spicy] food is really hot. Here we enter a whole new dimension of food for me: culinary danger! I liken this to the seaside big-dipper. When people come to the big drop, they scream in a mixture of fear and delight. It is a safe thrill. The authors use the analogy of bungee jumping. In the discussion of Paul Rozin's work in the areas a new culinary term is used that I have never come across before 'benign masochism'. When I next have a curry I will treat with a bit more respect!

This book is not for the faint-hearted as you can see in Chapter 7! I have watched many a TV programme featuring experimental practical archaeology: just how did they move the multi-tonne stones to Stonehenge? Let us get 100 people and experiment with rollers etc. Prehistoric mankind had a food problem. Being a hunter gatherer had periods of fest and famine. Kill a mammoth and you have lots of food for a long time, if and only if, you can preserve it. The palaeontologist Daniel Fisher was intrigued with the problem and decided to do some experimental archaeology to see if Clovis hunter-gathers could store meat. The experiment runs something like this: take one horse (dead of course) and cut it up into suitable joints. Drop these though a hole cut in the ice of a pond and weight them down to sit on the mud. Return over a period of weeks and retrieve samples. Scrape off the mud and algae and cut off a generous slice, then cook on hot coals. The flavour was said to be 'Like beef, but sweeter and a little sour'. This is one experiment I will not be replicating. I will stick to my baby freezer!

In the study of Cosmetic Science microbiology plays only a small part with consideration of preservation of systems (e.g. emulsions) that are susceptible to spoilage. In Food Technology it is a wholly different ball game. Food spoilage is more important, since organisms that cause illnesses like botulism can kill you. Microbiology is both friend and foe! Microbiology provides a host of products we enjoy such as: beer, wine, cheese, preserved meat (e.g. ham) and fish (e.g. Swedish surströmming). Chapter 8 The Art of Cheese is a delight and celebration. In Tavistock (a small UK Westcountry market town) there is a temple (well a small chapel!) to cheese. This tiny shop has a counter groaning under the weight of cheese from around the world with special emphasis on locally produced artisan cheeses such as the famous Blue Vinny.

The chapter extols the delight of such artisan cheeses with a case study of Cabrales cheese made (possibly better described as created) in Carreña, Spain. Of course, temperature control is an important contributor to the production process. You do not need an elaborate microprocessor temperature-controlled room; it's much more fun and artisan to use a cave (humidity controlled as well!) infected with Penicillium fungus. You can then lovingly mature your cheeses under the right conditions for a fair period (this is diametrically opposite to fast food!). This process goes far beyond the need to simply preserve food rather the objective is to create wondrous, complex flavours. These are to be enjoyed in good company with other good food and regional wine. This explains my monthly pilgrimage to

continued from previous page >

Tavistock to purchase my monthly supply of various cheeses. In the last edition of the ICATS Newsletter we reviewed *The Chemical Story of Olive Oil*. Most conveniently next door to the temple of cheese is the shrine of olives: a shop that only sells olives (sumptuously marinated in various flavoured olive oils) and olive oils from around the world.

Perfumes have often been described as 'More than a nice smell'. Good food is more that fuel to go. The culture of 'fast food' and the continued growth in home delivery services does enable some small local producers to reach a wider marketplace. Sadly, more often, there is a disconnect developing with some people from the provenance and subsequent preparation, not of good food, but of great food.

This brings us to the pinnacle of this brilliant book with Chapter 9: *Dinner Makes Us Human*. The quotation at the start of the chapter is particularly appropriate:

> *Food and language are not only close neighbours ...*
> *they occupy the same house*
> Gordon Shepherd

In our busy life, the quick breakfast and away may be necessity but we should find time to come together to talk, eat and socialize. In the UK a sign you could often see during the COVID19 crisis was 'Keep social distance – 2 metres'. Before central heating and air conditioning the kitchen table and fireside conversation were a fact of daily life. It was the [only] warm part of the house in winter! Dinner makes us human and brings us together with conversation between people in good company. Great food lovingly prepared should be savoured slowly and appreciatively.

This well-written accessible book is meticulously researched. The 30 pages of copious chapter notes and 17 pages of carefully selected key references give the serious student or researcher the path to further information. At £16.85 it is a bargain. Do get your own copy and pass it onto friends and then you can discuss it over some splendid food and discuss that as well!

BOOK REVIEWS

MOUTHFEEL: How Texture Makes Taste

Reviewed: **Dr Tony Curtis**

I found the title of this book slightly misleading. It is so much more that just about mouthfeel. The first three chapters provide an excellent introduction to the context of the enjoyment of food. It nicely fills a gap in my bookshelf between:

> *Food Science and Technology* (2nd edition) with its galaxy of eminent authors and authoritative Editor (Geoffrey Campbell-Platt, Reading Professor of Food Technology). This provides excellent academic cover of the various aspects of food technology. That is why it is a key reading text for the IFEAT / ICATS course (Flavour pathway).
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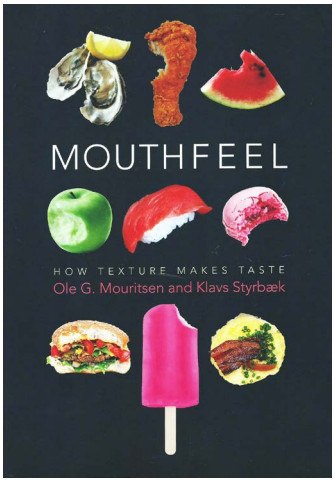
> *The Food Lab; Better Home Coking Through Science* (J. Kenji López-Alt) is a masterful cover for the serious domestic cook (and all good chefs!). I well remember reviewing it and thinking it was going to be expensive with its cover of alluring kitchen utensils (he is lyrical about Japanese kitchen knives – wonderful but expensive!).

Mouthfeel is nicely complementary. Of necessity *Food Technology* is divided into specific component aspects (e.g. food analysis). The *Food Lab* does what it says on the tin – it is kitchen orientated. Mouthfeel starts from a different perspective. Chapter One: *The Complex Universe of Taste and Flavor* explores the multidimensionality of the food experience.

I particularly liked the sections on *The Interplay Between Mouthfeel & Sensory Impressions and Neurogastronomy: Flavour is All in the Brain*. In the academic study of a subject it is often necessary to divide it into appropriate 'subjects'. Key elements are set out on page one of *Food Technology*. The introduction of this highlights that:

> Students need to have undertaken courses in the basic scientific disciplines of chemistry, biology, mathematics, statistics and physics.

This is entirely correct and necessary. However, something is lost in this approach. In the UK there is a radio channel devoted to what might be called popular classical music (Classic FM). In the early morning programme favourites are played such as *A Young Persons' Guide to the Orchestra*. This specific composition attempts to illustrate the various contributions that individual instruments make to the overall sound of the orchestra. This is some ways a different experience to normal classical compositions. August is a feast of music with the BBC Promenade season with a whole variety of outstanding music played live to an audience by great artists from around the



Ole G. Mouritsen and Klavs Styrbæk (Translated Mariela Johansen)

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world. Now enters a new component of the experience. When I listen to this, I not only hear sound but experience emotion. The BBC Promenade season is available on a worldwide basis with BBC World Service and internet access. Another favourite BBC World Service programme (it would be!) for me is the *Food Programme*. One format of the programme is to get a world-renowned chef to discuss their life and traditions around five key dishes that are culturally and emotionally important to them. Here again the experience could be described in chemical – physical terms but the specific focus in this programme is on the enjoyment and emotional experience of great food and drink. Just like music the total experience is more than a linear addition of the parts. We do not experience this simply on the tongue or the nose it is the interplay of the whole experience: *Neurogastronomy: Flavor is All in the Brain*

Chapters one to three provide the context, then the authors use a zoom lens to focus on the declared topic of the book with *Texture and Mouthfeel*. This sets the scene for the nuts & bolts of what this book is all about: *Playing Around with Mouthfeel*. I was aware of the special and complex nature of chocolate (Page 151 has an illustrative vignette: *Chocolate: Why it melts in your mouth*). A whole new vision opened on my refrigerator door with this section: *The Surprising Diverse Texture of Milk*. It is said that milk is not the same as it used to be. Now I understand some of the reasons. A modern child will not really know what 'Cream on top of the milk' is with our almost universal adoption of homogenised milk. Cream comes to us in a carton, not on top of the milk now. The story does not stop there the tale goes on with *Butter and Its Very Particular Mouthfeel*. In its way butter is just as complex in its melting in the mouth as chocolate.

This chapter also illustrates another special and welcomed feature of this book. Yes there are lots of recipes but this is no simple dictionary of instructions. On page 154 we have the instructions for *Amy's Apple Pie* (sounds delicious). We are then treated to *Amy's Crisp Apple Pie: A Physicists Approach to Mouth Feel*. These recipes (lots of them!) are experiments to illustrate aspects being discussed. However, they are a lot more appetising than the titrations of my early Chemical Laboratory experiences. Not for nothing was Chemistry often described at school as 'stinks' as a result of the use of H2S used in qualitative inorganic analysis.

Module 3 of the IFEAT / ICATS Diploma Course is the largest unit. Just as artists have to know their paints and architects have to understand their bricks and mortar Creative Perfumers and Flavourists need to know their building blocks: essential oils aroma extracts and aroma chemicals. Chapter 6: *Making Further Inroads into the Universe of Texture* takes us into how individual ingredients can function in contributing to mouthfeel e.g. page 219 *Grains and Seeds with a Multitude of Texture*.

The book concludes with two very appropriate high notes: Chapter 7: *Why Do We Like the Food that We Do?* and the Epilogue: *Mouthfeel and a Taste for Life*. This is a book that is within the personal budget and should be on the shelf of all involved in food development, not only Food Technologists but also Chefs and keen home cooks. It is a good read and has lots of beautiful illustrations worthy of the best traditions of 'coffee table' cook books (admired but not much used!). It also has the academic rigour of textbooks such as *Food Science and Technology*. Do buy; it will make a much welcomed and loved addition to your library.

ICATS

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