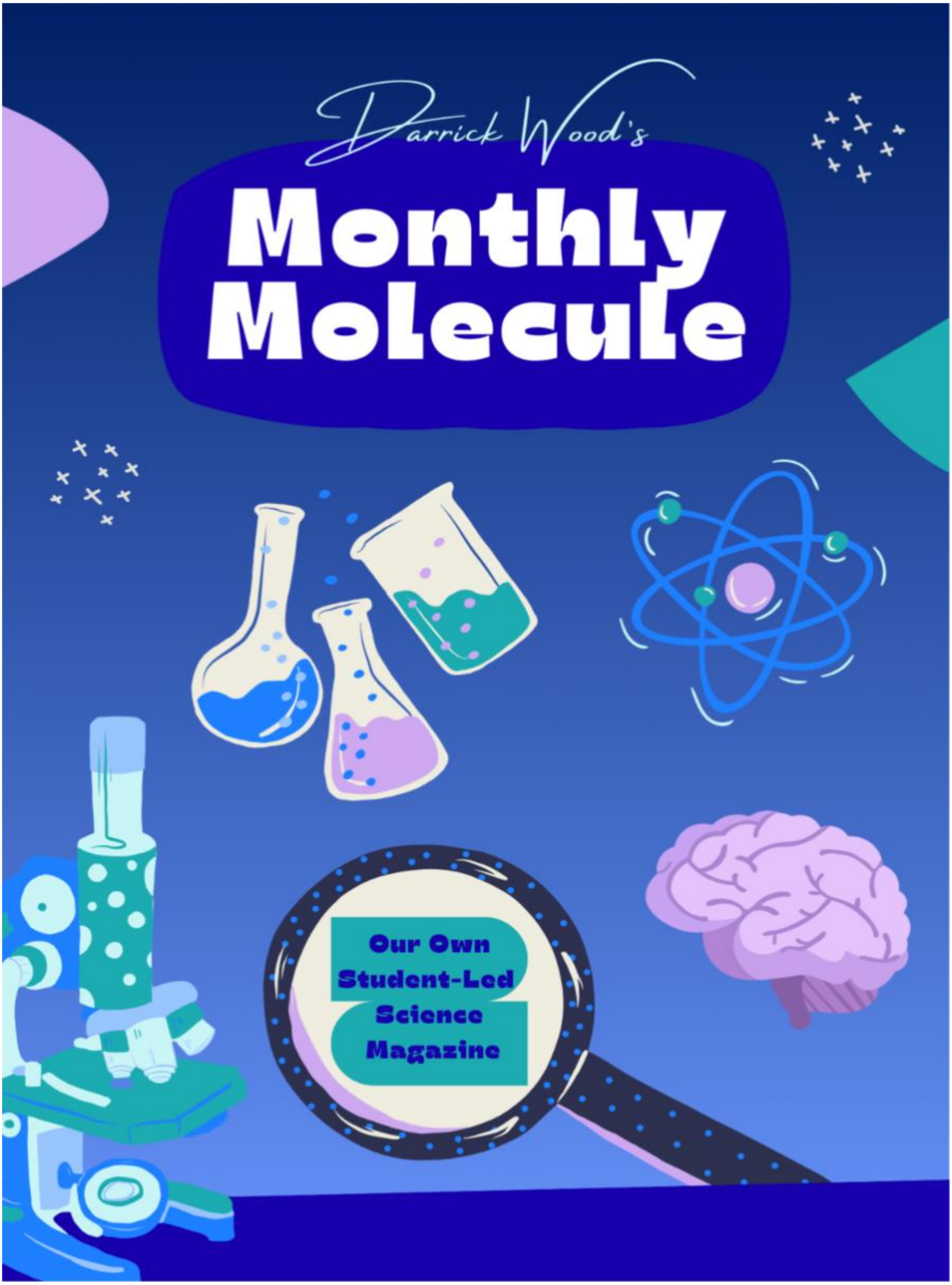

Darrick Wood's
Monthly
Molecule
Our Own
Student-Led
Science
Magazine

Contents

Edited by Jasveer Thind 12VHA

Cover by Chloe Ancaja 12ABE

If you are considering writing for *The Monthly Molecule*, now is the ideal time to start. It’s open to everyone, and each edition is a chance to explore ideas, develop your writing, and share something you are genuinely interested in. However, with only a few issues left this year, time is starting to run out to be part of this year’s publications. Even a short article can make a real impact, whether it explains a concept, explores a debate, or shares something you’ve discovered. Just think about how writing an article about your field of study will look in university personal statements.

Magic doesn't run your code...

By Eren Kaşlı 10YH

And I'll tell you what does. Well two things can actually, and they are similar, *except for when they are not*. Those are **interpreters** and **compilers**.

Interpreters? Compilers? What are they? Well... good question. An Interpreter is a program that takes your code and then runs it one by one (it doesn't, but I'll explain later). A compiler is a program that takes your code and converts it to code that the computer itself can run. The way the code is processed for the two are very similar, we will go over compilers first:

1. Turn the code into a bunch of **tokens**. These tokens are data structures that can be used during the **parsing** stage.
2. **Parse** it. This is when it essentially turns those tokens into a structure that the computer understands - this is where the validation happens, such as when it checks for syntax errors and makes sure the input adheres to the rules of the programming language.
3. Generate the code. Now for simplicities sake we will just assume that it generates the **machine code** that the computer understands, but real compilers often generate code in another programming language (an intermediate representation as it is called), and often does it multiple times until the machine code is generated
4. And then a program called linker makes sure that other code that our program we write relies on is linked, which this part does work with magic (get a copy of this article from SC1 Miss Easterby if you want an article about linkers for the next article)

Examples of compiled languages include C, C++, Rust, Go and more.

Interpreters also work in a similar way to **compilers**, with steps 1 and 2 being the exact same. However, rather than producing **machine code** that the computer directly runs, it produces something called **bytecode**. Bytecode is essentially a version of machine code that is run by a program (in this case our interpreter) instead of by the computer itself. It is not the same as machine code, and it cannot be run by the computer itself. It also varies between different programming languages.

Interpreters then run this bytecode that is produced. And unlike with compilers where it only produces the executable file that is then ran by the computer when the user wishes to, interpreters also run the bytecode, which means that interpreters directly ran the code – such as with python where you simply click run on IDLE and the python interpreter runs the code.

Examples of Interpreted languages include Python, JavaScript, Lua and more.

Interpreters	
Pros	Cons
Your code will run on any operating system that the interpreter supports. You can edit the code and then run it without having to compile it every time – like how you do with Python.	Horrendously slow. Requires another program (the interpreter) to run the program that you distribute. Users can see your source code which isn't great if you want to keep your code secret

Compilers	
Pros	Cons
Your program will run much faster than with interpreters. The user can run your program by simply double clicking on your executable file. You can keep your source code hidden as the resulting machine code is not human readable.	Compile times are often quite slow – every time you want to change something, you need to recompile your code. You need to compile for every single platform you intend to support.

Could a Teenager Really Hack NASA - and What Does That Say About Cyber Security Today?

By Caleb Poole - 12KEA

NASA, the organisation that sends astronauts into space and operates billion dollar missions, protected by some of the most advanced technology on Earth, hacked by a teenager? In 1999, that's exactly what happened. This story reveals something surprising about cyber security: even the strongest systems can fall apart because of the smallest weaknesses.

The incident began when NASA engineers noticed unusual activity inside their computer network. Files were being accessed at strange times, data was being copied, and parts of the system were slowing down. After investigating, they discovered that someone had broken into computers used to support the ISS (International Space Station). The intruder had downloaded software worth over $1.7 million, and the breach was so serious that NASA had to shut down parts of its network for 21 days. The hacker wasn't a part of a criminal organisation or a foreign agency. It was Jonathan James, a 15-year-old from Florida, working from his bedroom.

The most shocking part is how he did it. James didn't use advanced malware or expensive tools. He simply took advantage of basic weaknesses; weak passwords, unpatched systems, and simple network vulnerabilities. Once inside, he installed a "backdoor", which is a hidden digital entrance that allowed him to return whenever he wanted. He didn't damage anything, but the fact that he could access systems linked to life support equipment on the ISS was enough to terrify experts. NASA later admitted that the attack forced them to completely rethink their cyber security systems.

Even today, many major cyber attacks begin with small, preventable mistakes. Weak passwords, outdated software, and careless clicks, causing more damage than the most sophisticated hacking tools. Cyber security isn't just about technology; it's about people and their mistakes.

The NASA case isn't unique. In late 2021 and 2022, Lapsus$ hacking group have hacked Uber, Rockstar Games, Microsoft, Samsung, Nvidia, and even X (formerly Twitter). A 17-year-old once took over celebrity bitcoin accounts in 2020, including Barack Obama and Elon Musk, simply by tricking a Twitter employee into giving up their login details (also known as social engineering). These incidents show that young people often understand technology better than the organisations trying to secure it.

There is a positive side to this story. The same curiosity that leads some teenagers to explore systems can also turn them into powerful defenders. Ethical hackers use their skills to find weaknesses before criminals do. Companies hire them to break into systems legally and help fix the flaws.

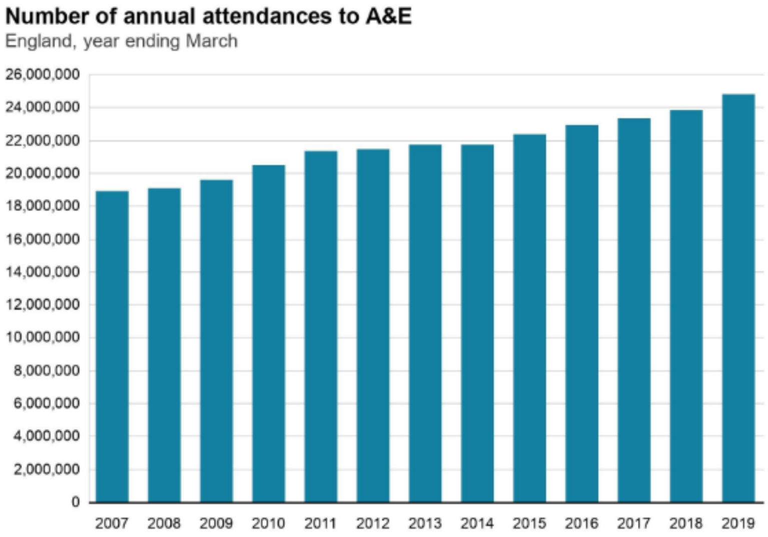
So, what does the NASA hack really teach us? It shows that even the most advanced systems can be penetrated by simple vulnerabilities. It shows that cyber security depends on people as much as technology.

From Data to Diagnosis: How AI Is Reshaping Healthcare

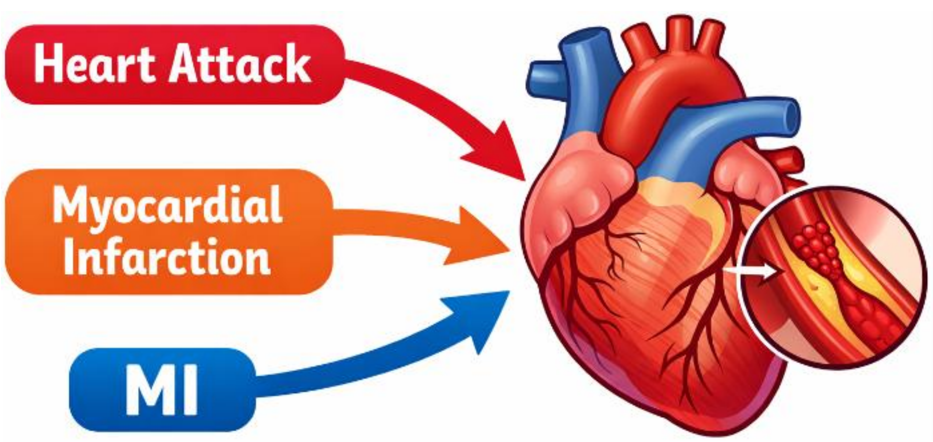
By Jasveer Thind- 12VHA

Why is AI helpful in healthcare?

The UK's National Health Service manages a large and growing demand for care, carrying out over a **million patient interactions every 36 hours**. Despite the dedication of healthcare professionals, challenges remain: many **diseases are still diagnosed too late for optimal treatment**, and **medical error continue to contribute to preventable.**



At the same time, hospitals generate vast quantities of data from scans, blood tests, and patient records that far exceed what can be manually analysed. This raises an important question: could artificial intelligence help improve the **speed, accuracy,** and **reliability** of healthcare delivery?



Medical data is highly complex and often incomplete. Patient records may not be updated consistently; missing test results are common, and different hospitals record information about patients and their conditions in different ways. For example, Hospital A might write **"heart attack"**, Hospital B writes **"myocardial infarction"**, whilst Hospital C writes **"MI".** To a human doctor, these all mean the same thing. However, to a computer system or AI model, they look like completely different labels, and it may not recognise that they are the same **condition**. This one of the reasons why AI struggles in healthcare when data is not consistent.

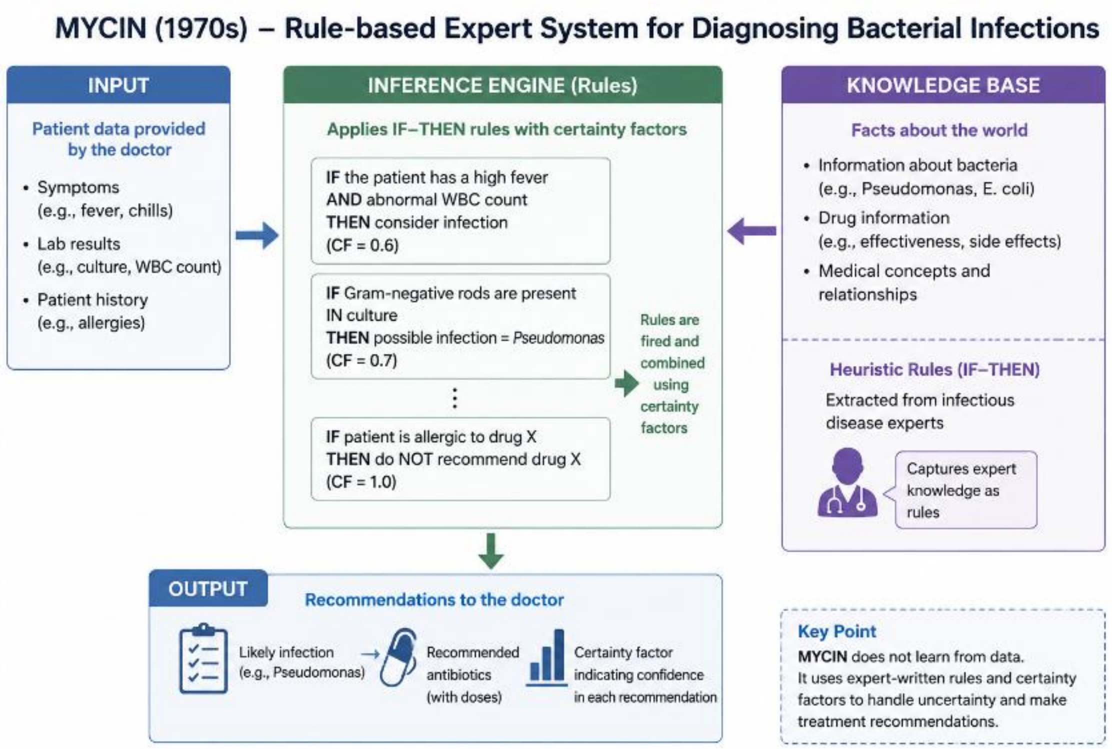
Clinical decisions are also high-stakes, mistakes made by AI in healthcare can directly harm patients. Unlike recommendation algorithms used in entertainment or shopping platforms, healthcare AI has a much more serious affect. This is why Healthcare AI must be much more reliable than normal technology.

AI also needs to be able to fit real hospital practice and needs to be fast enough to make decisions to support doctors who are working under time pressure. If tools are slow and require heavy human input, they can fail to be used even if they are accurate.

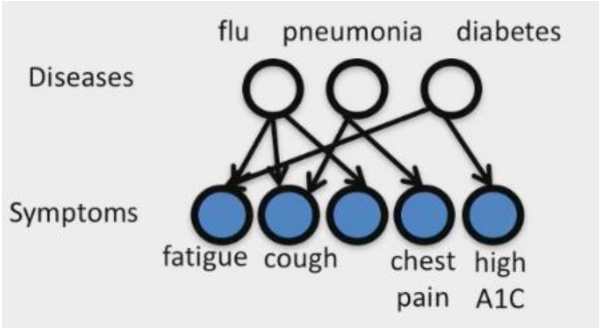
The history of AI in medicine

People have been trying to solve these problems associated with AI being used in hospitals for decades.

1970'S: MYCIN expert system



Attempts to use artificial intelligence in healthcare are not new, it dates to the 1970s, when researchers developed a system called MYCIN. It was designed to diagnose bacterial infections and prescribe antibiotics. It proposed a good antibiotic in roughly 69% of cases, which was higher than most disease experts. Despite this success rate, it was never widely used in hospitals. This is mainly because it relied on manually programmed rules and formulas rather than learning how to diagnose from large datasets based off previous cases. This meant it struggled to adapt to different clinical settings and real hospital workflows.



INTERNIST-1

INTERNIST-1 was another early AI system developed in the 1980's that helped doctors to diagnose diseases, especially in the field of internal medicine. It was very broad and was able to diagnose many diseases.

They did this by linking symptoms to possible conditions. The system stored huge numbers of relationships between diseases, symptoms, and patient information. It tried to mimic how doctors think when forming diagnoses by using known disease-symptom relationships.

However, despite its complexity, the system still depended heavily on manually programmed knowledge rather than learning directly from patient data. It also struggled to adapt across different hospitals and clinical environments, limiting its practical use in real healthcare settings.

Why AI Is Finally Starting to Work in Healthcare

Although early systems such as **MYCIN** and **INTERNIST-1** showed what might be possible, they also revealed the limitations of AI at the time. They relied on fixed rules written by experts rather than learning from real patient cases, which meant they struggled with the complexity and unpredictability of real hospitals.

Today, however, three major developments have transformed what AI can do in medicine: the rise of digital patient records, the creation of shared data standards, and the availability of large, high-quality datasets for training machine learning models.

Electronic Medical Records: The Foundation of Modern Healthcare Data

One of the biggest changes in healthcare has been the move from paper notes to **Electronic Medical Records (EMRs)**. These are digital versions of a patient's medical history, containing information such as:

- blood test results
- imaging scans
- medication lists
- allergies
- vital signs
- doctors' notes

In the UK, the NHS has rapidly increased its use of Electronic Medical Records. Today, over **90% of GP practices** use fully digital patient records, and **over 80% of hospital trusts** have implemented Electronic Patient Record systems, with the remaining trusts expected to go digital by 2026.

This shift matters because it creates a continuous, structured record of a patient's health. For AI, this is essential: algorithms can only learn patterns if the data is complete, consistent, and available in large quantities.

One of the most influential datasets in healthcare AI is **Intensive Care National Audit & Research Centre (ICNARC) Case Mix Programme**. ICNARC data helps hospitals benchmark performance and improve care quality. It contains detailed, anonymised data from over **300 adult ICUs across the UK** including:

- diagnoses and comorbidities
- severity scores (APACHE, ICNARC model)
- organ support data (ventilation, renal support, cardiovascular support)
- treatments given
- outcomes (survival, length of stay)
- some physiological measurements

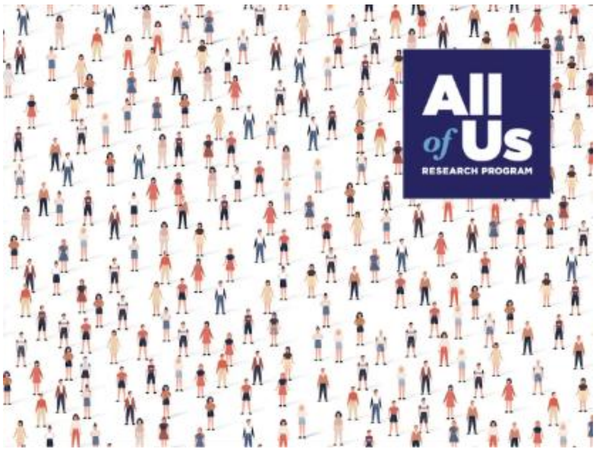
What makes MIMIC so important is its depth. ICU patients are monitored constantly, so the dataset captures how a patient's condition changes over time. This allows AI models to learn how diseases progress and how treatments affect outcomes.

For biomedical engineering, MIMIC is a goldmine. It provides real physiological data that can be used to design better monitoring systems, predictive models, and clinical decision support tools.

The All of Us Initiative: Data for Precision Medicine

Another major development is the **All of Us** Research Program, run by the US National Institutes of Health. Its goal is to collect health information from **one million people.**

The goal of this program is to support "precision medicine" — treatments tailored to individual patients.



The dataset includes:

- genetic information
- lifestyle and environmental data
- medical records
- wearable device data
- long-term health outcomes

This scale is unprecedented. By combining genetics with clinical data, researchers can study why certain treatments work for some patients but not others. For medicine, this means more personalised care. For biomedical engineering, it opens the door to designing devices and algorithms that adapt to individual physiology rather than relying on one-size-fits-all models.

Why These Datasets Matter

Early AI systems failed because they didn't have enough data to learn from. Today, datasets like EMRs, MIMIC, and All of Us provide:

- **size** — millions of patient records
- **variety** — notes, scans, lab tests, genetics, wearables
- **timing** — data collected continuously, not just at appointments
- **standardisation** — consistent coding systems such as **ICD-10**, **LOINC**, and **FHIR**

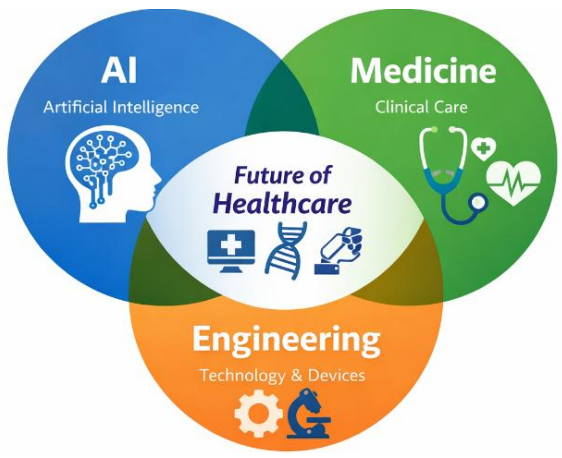
This combination allows AI to recognise subtle patterns that humans might miss, such as early signs of sepsis or the risk of a patient deteriorating overnight.

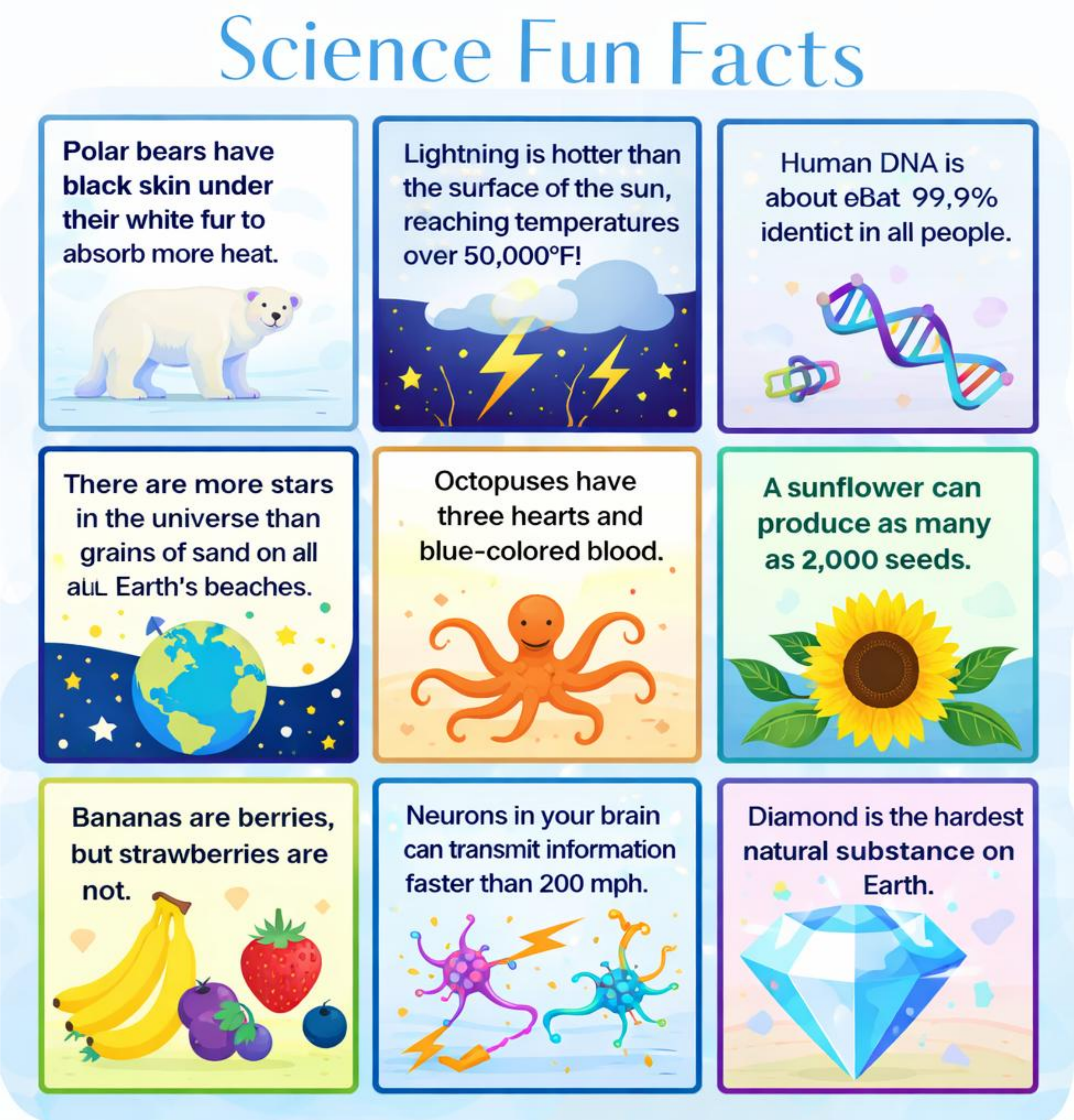
Why This Matters for the Future of Medicine and Biomedical Engineering

Modern healthcare increasingly depends on people who can understand both the clinical side and the technical side — people who can work with doctors to design tools that genuinely improve patient care.

AI is not just a piece of software; it is part of a wider system that includes medical devices, imaging technologies, electronic records, and clinical workflows. Developing these systems requires engineers who understand how hospitals operate, and clinicians who understand how technology can support decision-making.

As the NHS continues to adopt digital tools, this combination of skills will become even more important. Whether it is designing safer diagnostic algorithms, improving medical imaging, or ensuring that AI systems are fair and reliable, the future of healthcare will depend on collaboration between medicine and engineering.




Science Fun Facts
Polar bears have black skin under their white fur to absorb more heat.
Lightning is hotter than the surface of the sun, reaching temperatures over 50,000°F!
Human DNA is about eBat 99,9% identict in all people.
There are more stars in the universe than grains of sand on all aLL Earth's beaches.
Octopuses have three hearts and blue-colored blood.
A sunflower can produce as many as 2,000 seeds.
Bananas are berries, but strawberries are not.
Neurons in your brain can transmit information faster than 200 mph.
Diamond is the hardest natural substance on Earth.

Spot the mistake

Each paragraph contains 3 mistakes

1. Biology: Cells

All cells contain a nucleus, including bacteria. The cell membrane is only found in animal cells. Mitochondria carry out photosynthesis using light energy.

2. Biology: Infection

Antibiotics are used to kill viruses. Antibodies are white blood cells that swallow pathogens. Vaccines cure infections instantly by removing all microbes from the body.

3. Chemistry: Atoms

Atoms are made of molecules. Elements are made of compounds. During reactions, atoms are destroyed and new ones are created.

4. Chemistry: Acids

A higher pH means a stronger acid. Neutral substances have a pH of 14. All bases are acidic substances with pH below 7.

5. Physics: Forces

Mass is measured in newtons. Weight does not change with gravity. Gravity repels objects away from Earth.

6. Physics: Energy

Energy can be created in chemical reactions. Kinetic energy is stored energy. Light energy cannot move between objects.

7. Maths: Data

The mean is the middle value of a data set. Range is calculated by adding the largest and smallest values. Correlation always means one variable causes the other.

8. Maths: Probability

Probability can be greater than 1. An impossible event has a probability of 1. A certain event has a probability of 0.

9. Computing

RAM is permanent storage. The CPU stores files long term. Binary uses digits from 2 and 3.

10. Computing: Systems

The internet is one central computer system. A database is a physical storage device inside a keyboard. Software refers to hardware components.

ANSWERS

1. Cells

- Not all cells have nuclei (bacteria don't)
- Cell membrane is in all cells
- Mitochondria carry out respiration, not photosynthesis

2. Infection

- Antibiotics do not work on viruses
- Phagocytes swallow pathogens
- Vaccines prevent future infection, not instantly cure

3. Atoms

- Atoms are not made of molecules
- Elements are not made of compounds
- Atoms are rearranged, not destroyed

4. Acids

- Lower pH = stronger acid
- Neutral pH = 7
- Bases are pH above 7

5. Forces

- Mass in kg, weight in newtons
- Weight changes with gravity
- Gravity attracts objects

6. Energy

- Energy cannot be created or destroyed
- Kinetic = movement energy
- Light energy can be transferred

7. Maths data

- Mean = total ÷ number of values
- Range = highest − lowest
- Correlation ≠ causation

8. Probability

- Range is 0 to 1
- Impossible = 0
- Certain = 1

9. Computing

- RAM is temporary
- CPU processes data
- Binary uses 0 and 1

10. Systems

- Internet is decentralised
- Databases are software systems
- Software = programs, not hardware

Spot the Mistakes (Advanced Sixth Form Challenge)

1. Biology: Enzymes, Genes & Regulation

Enzymes increase the overall energy released in a reaction by lowering the final energy of products. All mutations in DNA lead to changes in the amino acid sequence and therefore always result in a change in phenotype. Gene expression is controlled only at the transcription stage, meaning once mRNA is produced, protein synthesis is fixed and cannot be influenced further.

2. Biology: Immunology & Disease Dynamics

Clonal selection occurs when antibodies mutate in response to antigens, allowing them to become more specific during infection. Vaccination works primarily by producing long-term circulating antibodies rather than generating memory B and T cell, providing lifelong immunity without the need for memory cells. Pathogen virulence always decreases over time because natural selection favours weaker strains that do not kill the host.

3. Chemistry: Equilibria, Energetics & Structure

A catalyst increases the equilibrium constant (Kc) by favouring the forward reaction and therefore increases product yield at equilibrium. Endothermic reactions release energy overall because energy released when bonds form is greater than energy required to break bonds., resulting in an overall release of energy. Ionic compounds conduct electricity in the solid state because electrons are free to move through the lattice structure.

4. Physics: Fields, Waves & Thermodynamics

Gravitational field strength is constant at all distances from a mass and only depends on the mass of the object creating the field. In electromagnetic induction, a current is only produced if a conductor moves parallel to magnetic field lines at constant velocity. The second law of thermodynamics states that entropy in a closed system decreases over time as energy becomes more organised.

ANSWERS (Advanced Sixth Form Challenge)

1. Biology

- Enzymes lower activation energy, not change energy of products
- Not all mutations change amino acid sequence (silent mutations exist)
- Gene expression is regulated at multiple stages (transcription, translation, post-transcriptional)

2. Immunology

- Clonal selection = selection of lymphocytes, not antibody mutation
- Long-term immunity relies heavily on memory B and T cells, not just antibodies
- Pathogen virulence does not always decrease; evolution can increase or maintain it

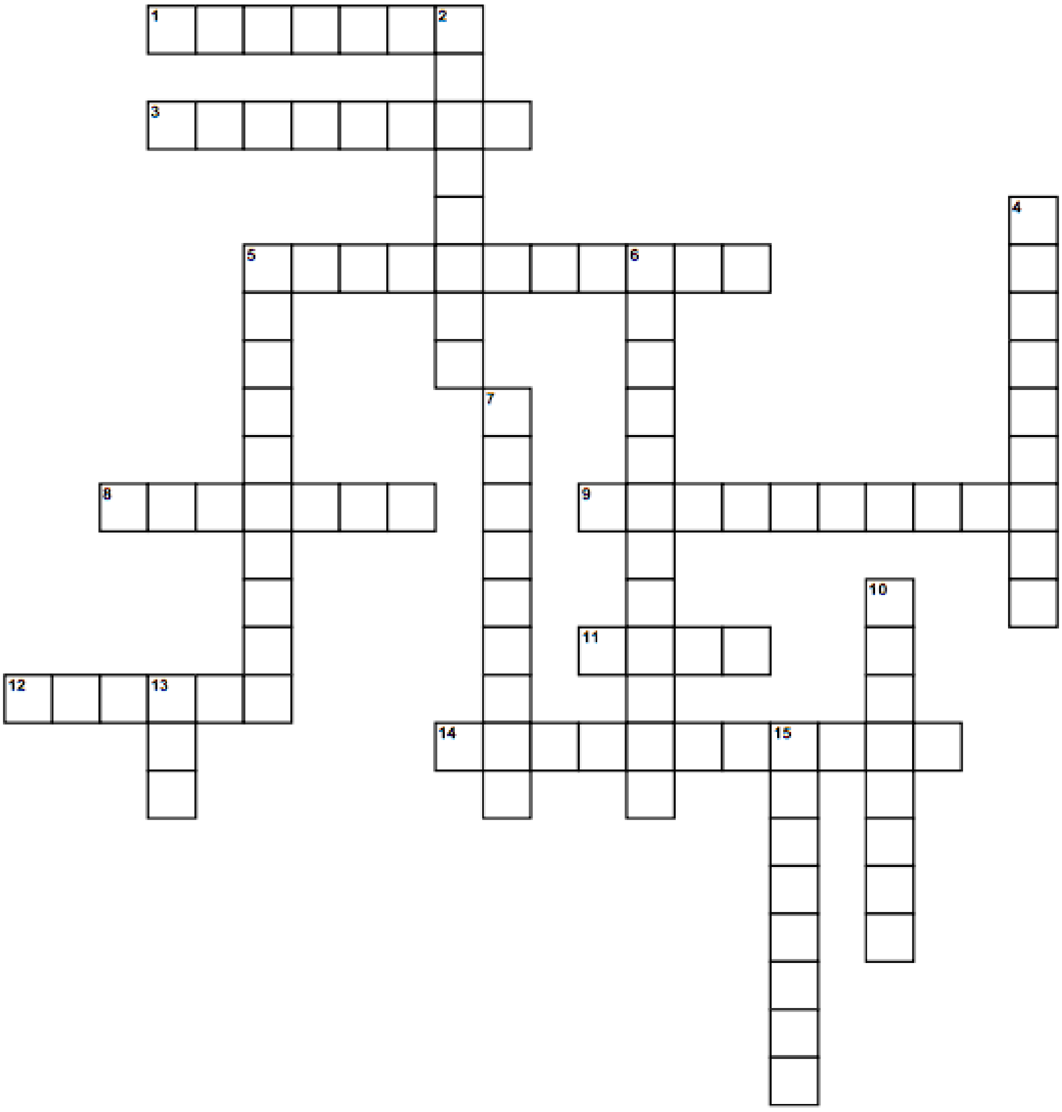
3. Chemistry

- Catalysts do not change equilibrium position or Kc
- Endothermic reactions absorb energy because bond breaking requires energy input exceeding bond formation
- Ionic solids do not conduct electricity (ions are fixed in lattice)

4. Physics

- Gravitational field strength decreases with distance (inverse square law)
- Induced current requires change in magnetic flux, not just motion parallel to field lines
- Entropy in a closed system increases, not decreases

Crossword



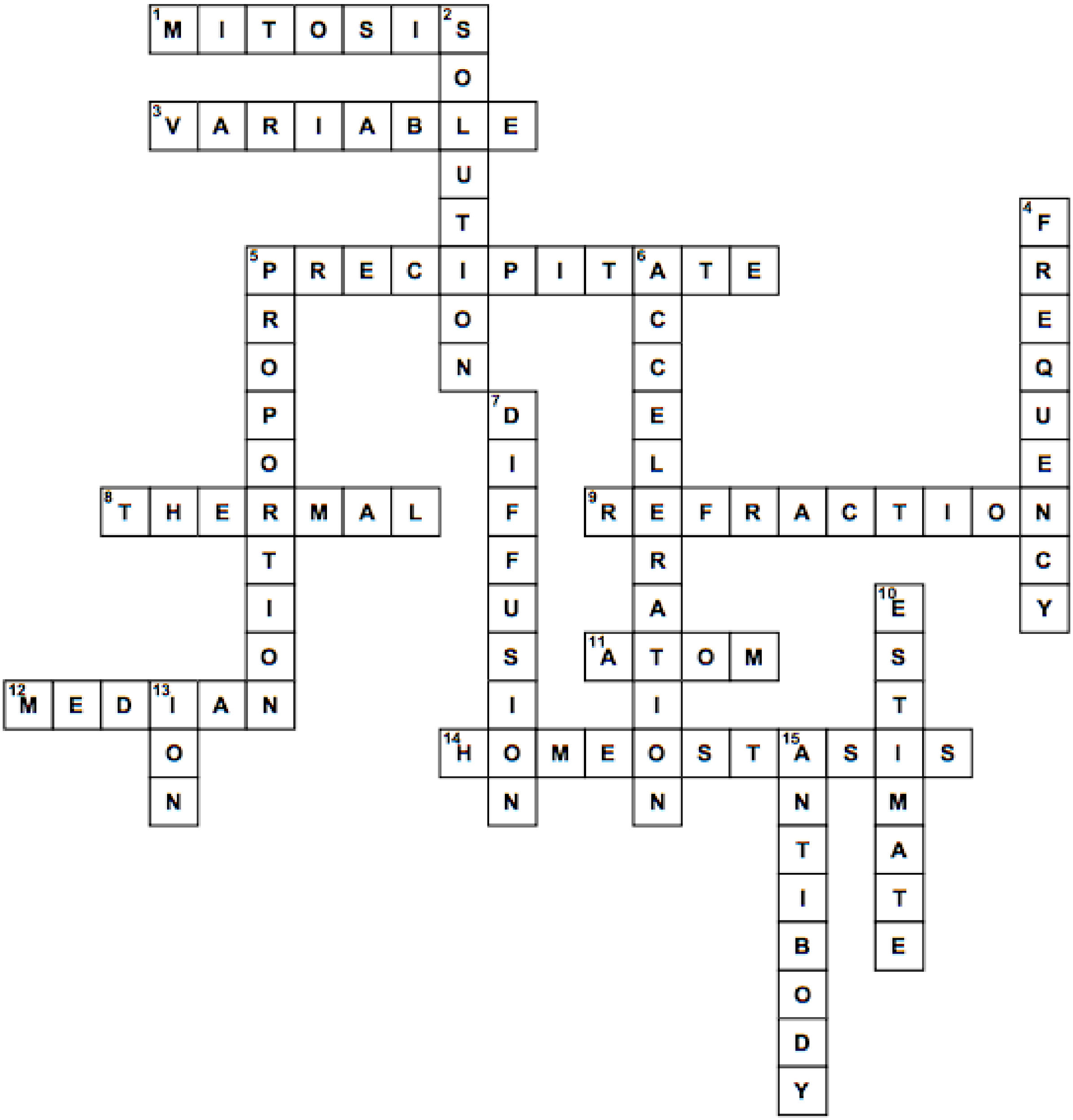
Across

[1] Type of cell division that produces two identical cells
[3] Quantity in maths that can change or take different values
[5] Solid formed when two liquids react together in a chemical reaction
[8] Relating to heat energy and how it is transferred
[9] Change in direction of light as it passes between different materials
[11] Smallest unit of matter that still retains the properties of an element
[12] Middle value when numbers are placed in order
[14] Process that keeps internal conditions in the body stable

Down

[2] Mixture where a substance is fully dissolved in a liquid
[4] Number of waves passing a point each second
[5] Relationship showing how parts compare to a whole
[6] Rate at which velocity changes over time
[7] Movement of particles from an area of high concentration to low concentration
[10] Approximate value found by rounding or reasoning
[13] Atom or group of atoms with a charge due to loss or gain of electrons
[15] Protein made by white blood cells that targets specific pathogens

Crossword answers



Wordsearch

I	N	E	Q	U	I	L	I	B	R	I	U	M	E	E
S	N	S	N	A	C	T	Y	E	T	O	N	S	D	S
T	I	T	N	N	O	O	T	I	D	T	A	I	O	E
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NEURON	ENZYME	HOMEOSTASIS	IMMUNITY
MITOSIS	DIFFUSION	ANTIBODY	EQUILIBRIUM
IONISATION	BONDING	ENTHALPY	OXIDATION
REDUCTION	REACTION	VELOCITY	FORCE
MEDIAN	RATIO		