

# The scientific case for homeopathy

## A word from our detractors...

“There is no scientific case for homeopathy: the debate is over.”



Prof Edzard Ernst

“Homeopaths create walls of obfuscation, and superficially plausible technical documents that support their case.”



Dr Ben Goldacre

“Homeopathy is the enemy of reason.”



Prof Richard Dawkins

# Problems with high dilutions

“It’s one drop in an Olympic swimming pool!”



Actually, it’s not. An Olympic swimming pool contains 2.5 million litres, or  $2.5 \times 10^9$  ml, or  $5 \times 10^{10}$  drops.

Concentrations of one part in  $5 \times 10^{10}$  are easily detectable with modern analytical equipment and similar to natural levels of many biochemicals.

# Problems with high dilutions



... so add another  $10^{60}$  drops

one drop is  $1/20$  of a ml ...

... so that's  $5 \times 10^{58}$  ml ...

... or  $5 \times 10^{55}$  litres ...

... which is  $5 \times 10^{52}$  cubic metres

A sphere containing that much water would  
have a radius of  $2.3 \times 10^{14}$  kilometres ...

... which is 24.2 light years ...

The chances of a 1 ml sample of the diluted  
solution containing a single molecule from the  
initial drop is similar to the chances of winning the  
National Lottery four weeks running.

... or three times the  
distance to the star Sirius!





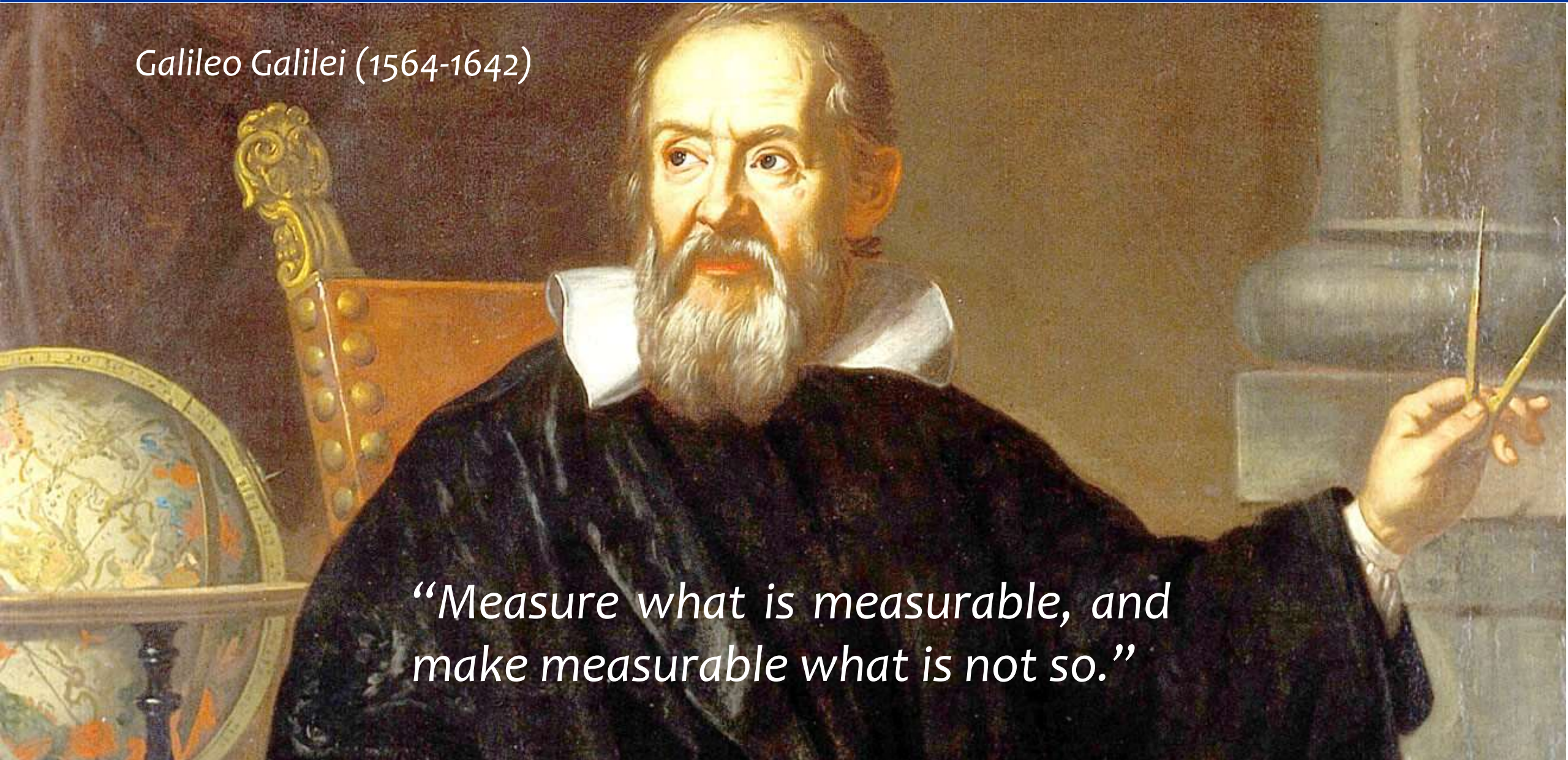
**But ...**

## Problems with high dilutions

- Any homeopath would agree that diluting something  $10^{60}$  times gives pure solvent
- Adding mechanical energy at each dilution step – succussion – is essential
- The central claim of homeopathy is that this process of serial dilution and succussion creates something in the solvent – “the potency” – which is the active agent
- The nature of this active agent remains unknown
- This should not be problem for science if there is sufficient evidence of the active agent’s actual existence – cf. dark matter in cosmology



Galileo Galilei (1564-1642)

A portrait of Galileo Galilei, an Italian astronomer, physicist, and engineer. He is depicted as an older man with a long, full white beard and mustache, wearing a dark, high-collared garment. He is seated in a wooden chair with ornate carvings. In his right hand, he holds a pair of compasses. To his left, a portion of a celestial globe is visible, showing various constellations and celestial bodies. The background is a simple, dark wall.

“Measure what is measurable, and  
make measurable what is not so.”

## Evidence of biological effects of the potency

**There is a large body of work:**

- **More than 20 experimental models**
- **Many hundreds of publications**
- **Over 70 studies are replications of previous work (69% reproducibility overall)**



## Evidence of biological effects of the potency

### Thyroxine and amphibian metamorphosis



- The most widely studied animal model
- Large body of data from 1990 to the present by different researchers in different laboratories on different continents



## Evidence of biological effects of the potency

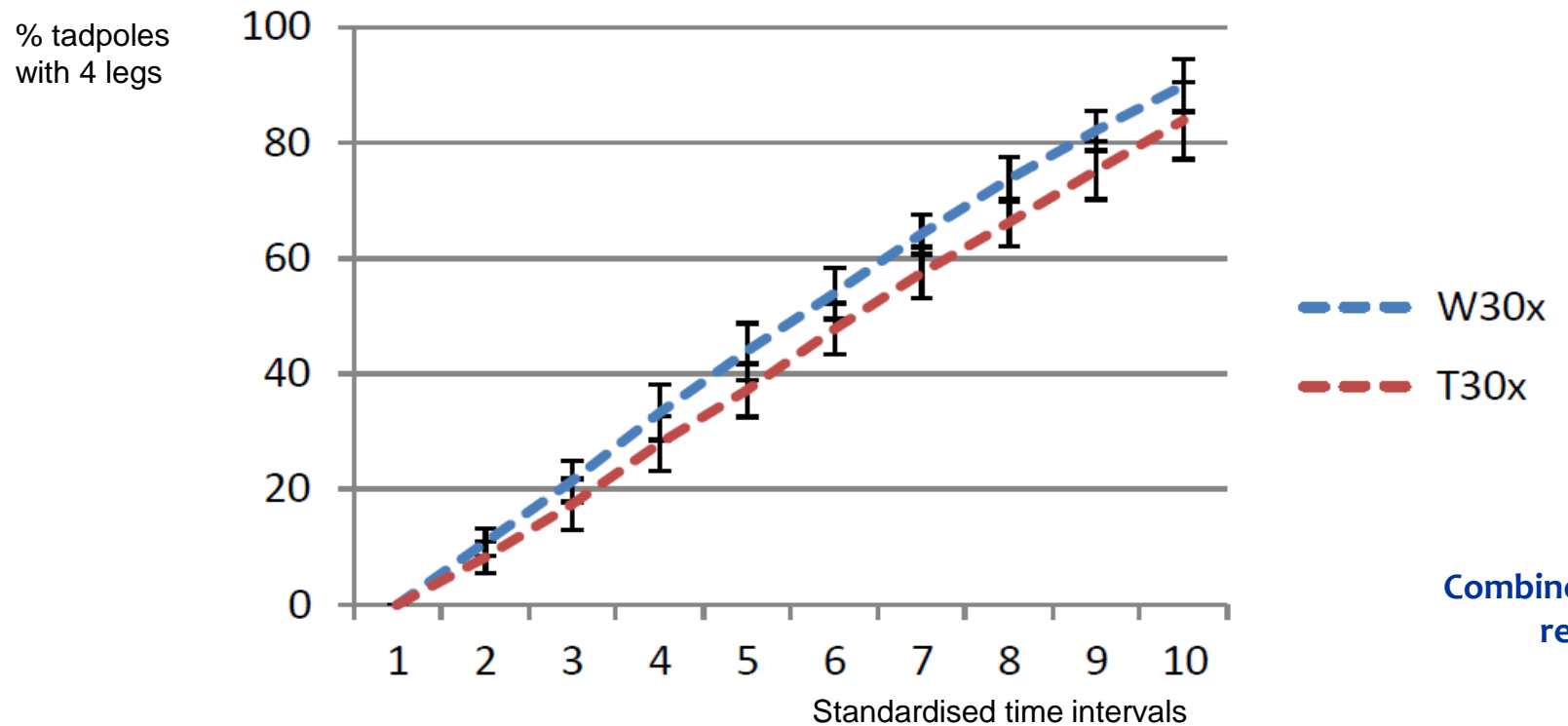
### Thyroxine and amphibian metamorphosis



- Transition from larva to adult regulated by thyroxine
- Treatment with thyroxine accelerates metamorphosis
- Thyroxine in potency slows metamorphosis, or blocks stimulating effect of molecular thyroxine

## Evidence of biological effects of the potency

Metamorphosis inhibited by potency of thyroxine

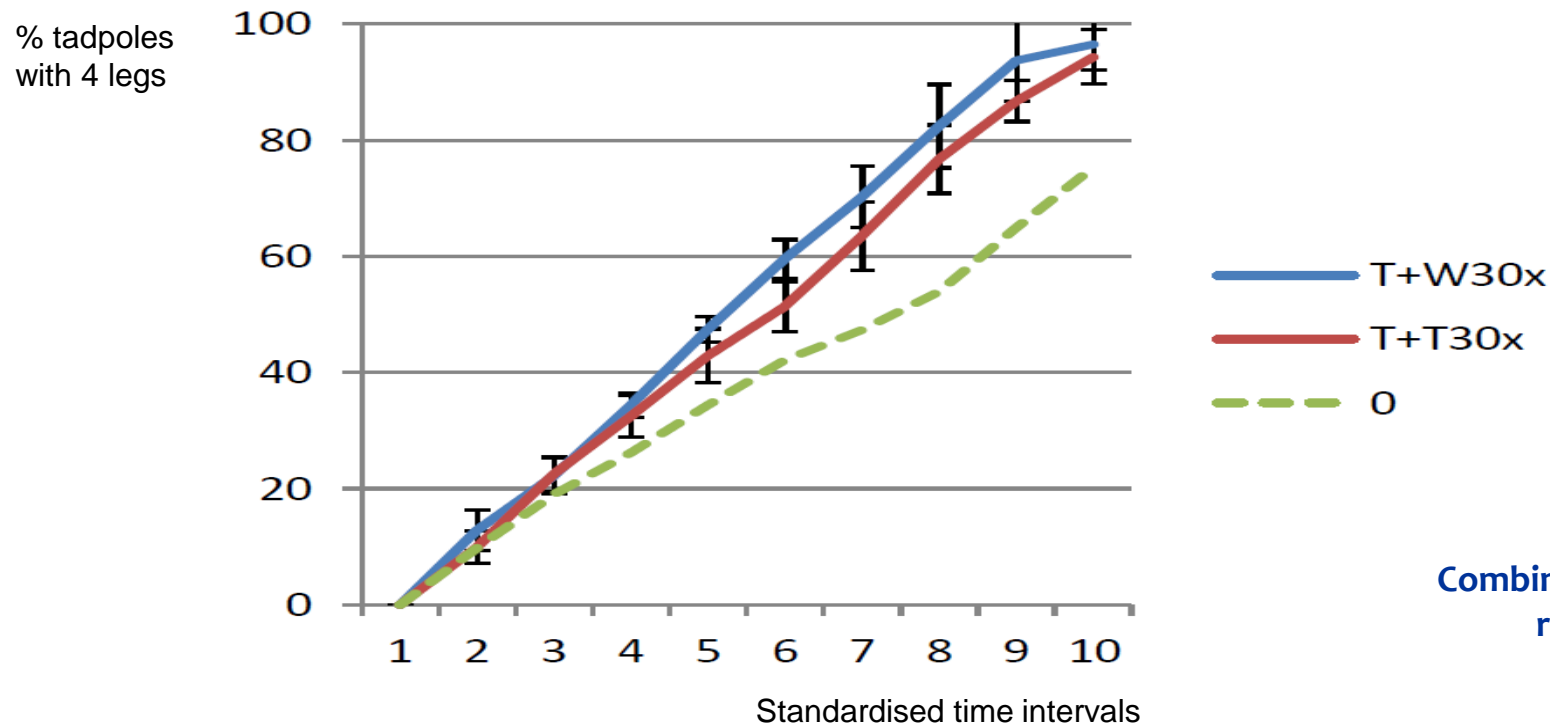


Comparison of  
diluted, succussed  
thyroxine (T30x)  
with diluted,  
succussed water  
controls (W30x)

Combined data from 20 experiments by 5  
researchers across 2 decades

## Evidence of biological effects of the potency

Effect of thyroxine inhibited by thyroxine potency



Comparison of  
diluted, succussed  
thyroxine (T30x)  
with diluted,  
succussed water  
controls (W30x) and  
untreated controls

Combined data from 20 experiments by 5  
researchers across 2 decades



## Evidence of biological effects of the potency

### Lemna gibba (duckweed) as a model



- Easy to grow
- Laboratory conditions can be tightly controlled
- Growth rate can be measured automatically

## Evidence of biological effects of the potency

### Lemna gibba (duckweed) as a model



- Easy to grow
- Laboratory conditions can be tightly controlled
- Growth rate can be measured automatically
- Very fast vegetative propagation



## Evidence of biological effects of the potency

### The Lemna gibba model

- **Work of Claudia Scherr, Research Institute of Organic Agriculture, Frick, Switzerland**
- **Extremely careful, highly controlled experiments, each with a very large number of replications**
- **Publications give very full details of equipment and methods**
- **Great attention to controls to look for sources of false positives**





## Evidence of biological effects of the potency

### The Lemna gibba model

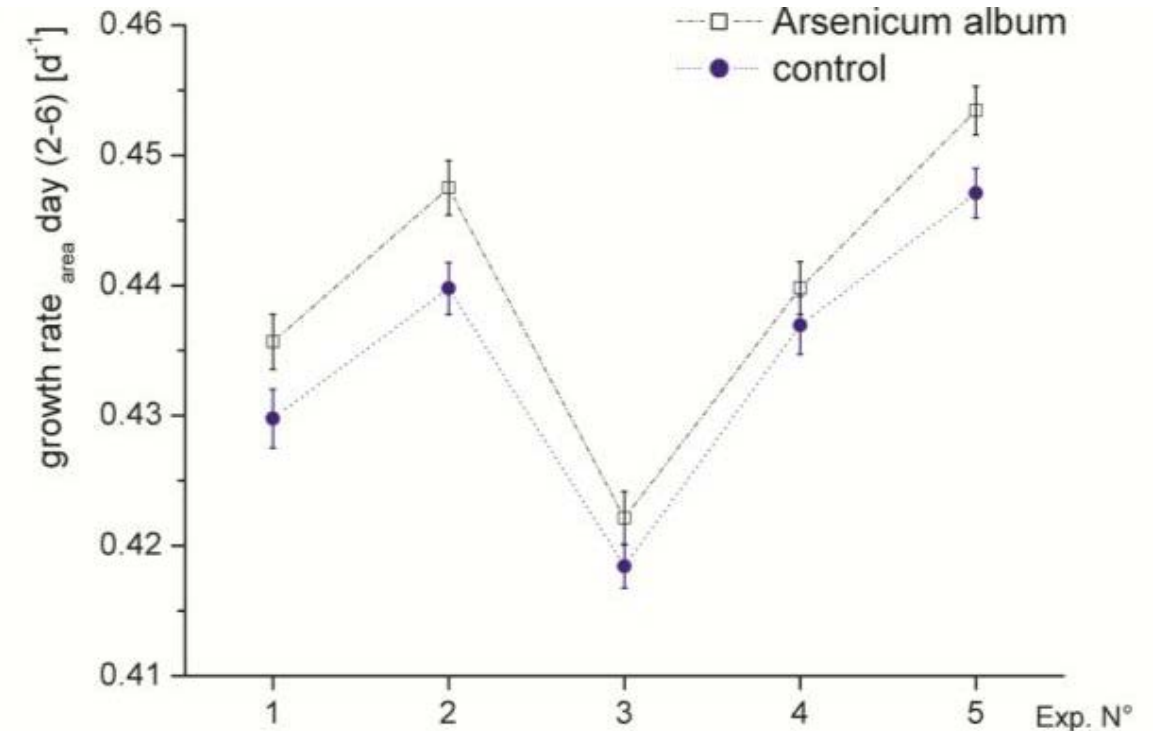
- **Various experiments undertaken:**
  - **Effects of potentised growth hormone (gibberellin)**
  - **Isopathic effects – protection from the effects of a toxin by a potency of the same toxin**



## Evidence of biological effects of the potency

### The Lemna gibba model with isopathy

- Plants stressed with sub-lethal dose of pentavalent arsenic for 48 hours
- Stressed plants then grown in water containing Ars alb 5x
- Treated plants grew better than controls

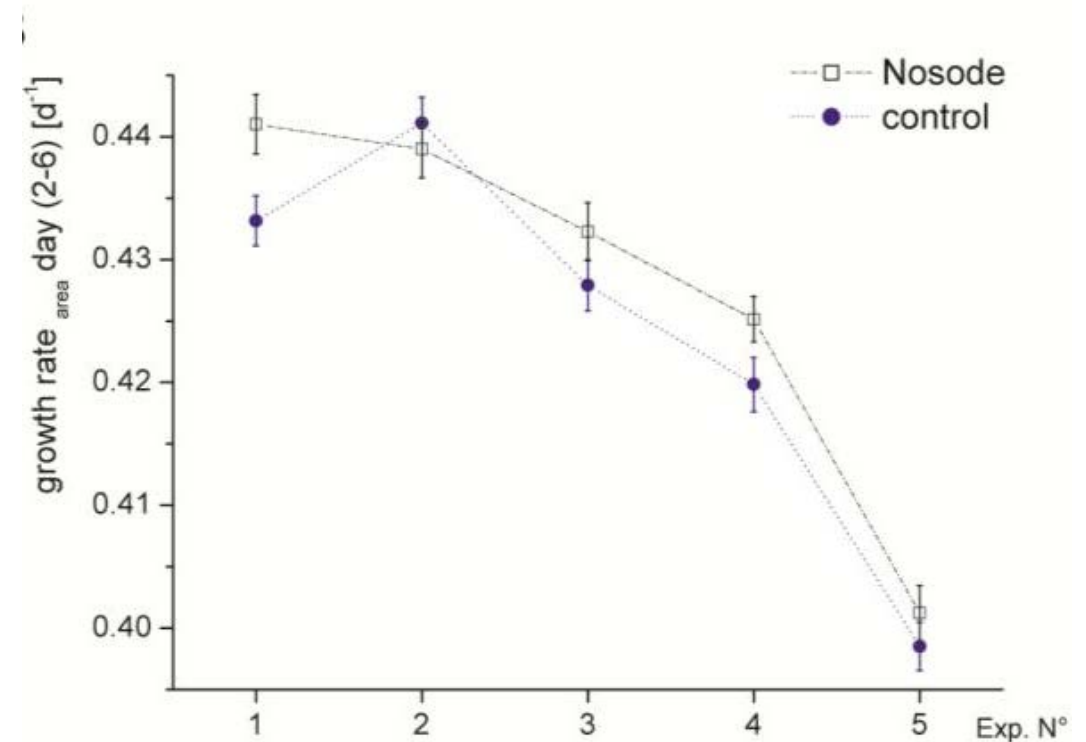




## Evidence of biological effects of the potency

### The Lemna gibba model with nosode

- The arsenic-stressed plants were macerated and prepared into a potentised nosode
- The nosode was then added to the growing medium of other arsenic-stressed plants
- The nosode had a similar effect to potentised arsenic

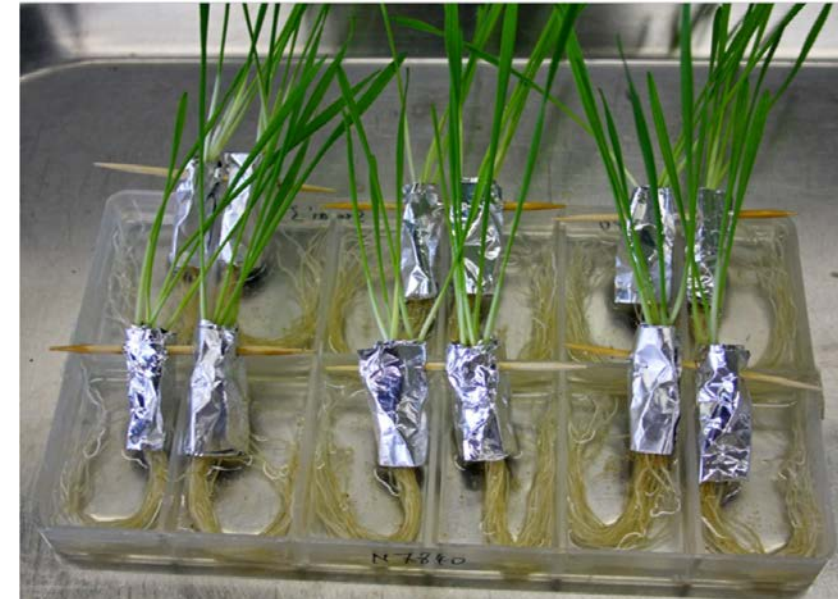




## Evidence of biological effects of the potency

### Arsenic in wheat seedlings

- Model has been studied since 2000
- Many experiments have shown similar results to the *Lemna* model
- More recent work<sup>1</sup> has used advanced techniques such as investigating effects on gene expression using DNA microarray analysis



<sup>1</sup>Marotti I, Betti L et al, *Transcriptome Profiling of Wheat Seedlings Following Treatment with Ultrahigh Diluted Arsenic Trioxide* Evidence-Based Complementary and Alternative Medicine Vol 2014, Article ID 851263

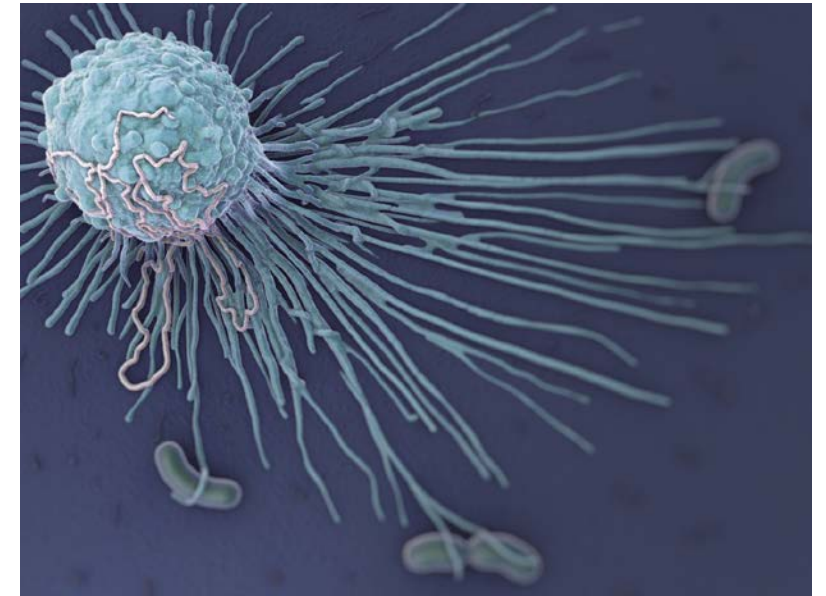
## Evidence of biological effects of the potency

### Arsenic in wheat seedlings

- **Poisonous levels of arsenic up-regulate many genes, particularly those coding for histones**
- **Arsenic potency (45x) has a major and reproducible effect on the same genes, down-regulating them to normal levels**
- **Arsenic 45x also down-regulates the same genes in healthy seedlings**

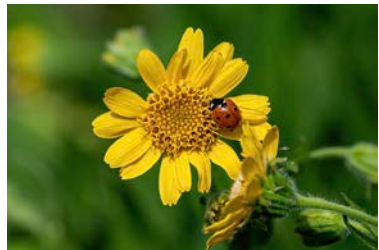
## Evidence of biological effects of the potency

- Macrophages have an important role in wound healing (among much else)
- Arnica has long been used as a trauma remedy, reducing inflammation and promoting healing
- The current work used real-time PCR to examine gene expression in macrophages incubated with Arnica potencies from 2C to 15C





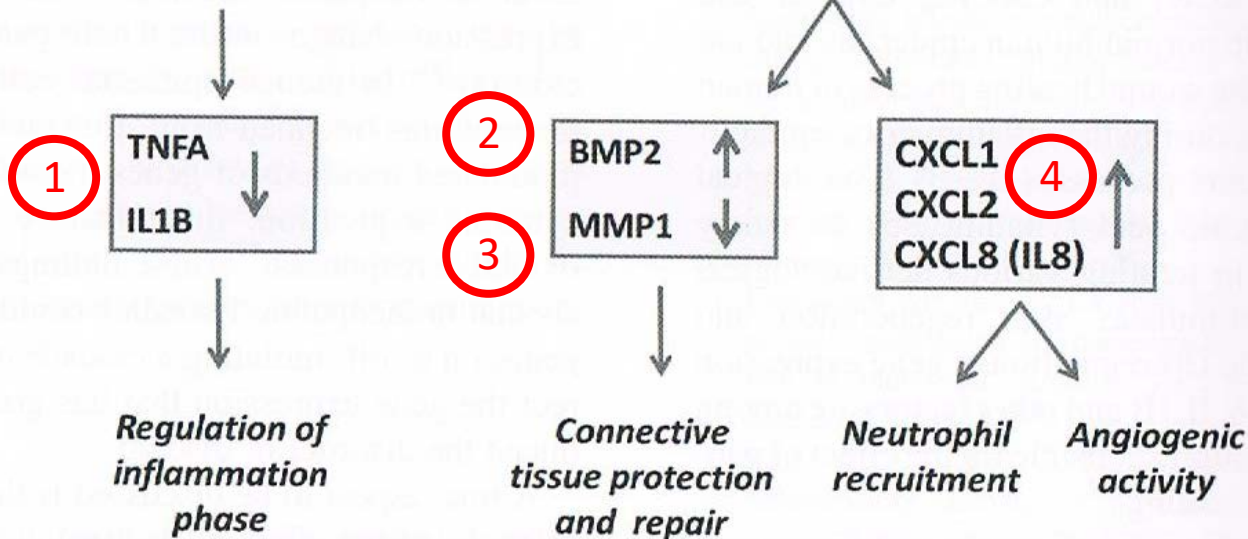
## Evidence of biological effects of the potency



*Arnica montana* L.

Normal Macrophages  
(Active in inflammation phase)

IL-4 Macrophages  
(Active in wound healing)



This nicely explains the therapeutic effects of Arnica:

- (1) Genes for proinflammatory cytokines in normal macrophages are down-regulated, reducing inflammation  
... while in IL-4 activated macrophages:
- (2) Bone morphogenetic protein 2 is up-regulated, promoting bone and cartilage healing
- (3) Matrix metalloproteinase 1 is down-regulated, protecting the integrity of the extracellular matrix
- (4) Various chemokine genes are up-regulated, all with various healing-promoting effects

## Evidence of biological effects of the potency - Conclusions

- **A large body of evidence demonstrates that homeopathic potencies, whatever they are, exert measurable effects on a wide range of living organisms across the plant and animal spheres**
- **Many results are highly reproducible, and some experiments have been independently replicated several times by separate laboratories on different continents**
- **As analytical techniques have advanced over the years, findings have become more robust**
- **Modern genetic techniques show that homeopathic substances act at a cellular level, exerting effects upon gene expression**

## Evidence of the physical existence of the potency

### Nuclear magnetic resonance

- NMR experiments began in 1992<sup>1</sup>
- For a long time remained largely the work of one investigator
- Indications of nano-scale structures from the outset<sup>2</sup>

<sup>1</sup>Demangeat JL, Demangeat C, Gries P, Poitevin B, Constanstinesco A *Modifications des temps de relaxation RMN à 4 MHz des protons du solvant dans les très hautes dilutions salines de silice/lactose* J Med Nuc Biophy 1992 16 (2) 135-45

<sup>2</sup>Demangeat JL *NMR water proton relaxation in unheated and heated ultrahigh aqueous dilutions of histamine: Evidence for an air-dependent supramolecular organization of water* J Molecular Liquids 2009 144 32–39

## Evidence of the physical existence of the potency

### Nuclear magnetic resonance

- More recent NMR experiments<sup>1,2</sup> confirm previous findings:
  - Potencies can be discriminated from controls at a very high level of significance (  $>5 \sigma$  )
  - Potencies showed structure at the molecular level with slowed thermal motion
  - The material configuration of the potency depended upon the starting material, the containers used, dissolved gases and the electromagnetic environment

<sup>1</sup>Van Wassenhoven M et al. Nuclear Magnetic Resonance characterization of traditional homeopathically manufactured copper (*Cuprum metallicum*) and plant (*Gelsemium sempervirens*) medicines and controls Homeopathy Feb (2017) 106, 223-239

<sup>2</sup>Van Wassenhoven M et al. Verification of Nuclear Magnetic Resonance Characterization of Traditional Homeopathically Manufactured Metal (*Cuprum metallicum*) and Plant (*Gelsemium sempervirens*) Medicines and Controls Homeopathy (2020) DOI: 10.1055/s-0040-1710022



## The Dynhom project<sup>1</sup>

# Evidence of the physical existence of the potency

- **Used a variety of sensitive methods:**
  - Nuclear magnetic resonance
  - Ultra high performance liquid chromatography (UHPLC-UV)
  - Inductively-coupled plasma mass spectrometry (ICP-MS)
  - Dynamic light scattering
  - Nanoparticle tracking analysis
  - Scanning electron microscopy with energy dispersive X-ray spectroscopy
- Potencies contain a range of nanoparticulate matter which is dependent upon, but not derived from, the starting substance
- This matter affects the behaviour of the solvent
- It remains present in impregnated pills and drops

<sup>1</sup>Van Wassenhoven M et al. *Nanoparticle Characterization of Traditional Homeopathically-Manufactured Cuprum metallicum and Gelsemium Sempervirens Medicines and Controls* Homeopathy 2018; 107(04): 244-263

## Evidence of the physical existence of the potency



**Steven Cartwright PhD**  
**Cherwell Innovation Centre**  
**Oxford**

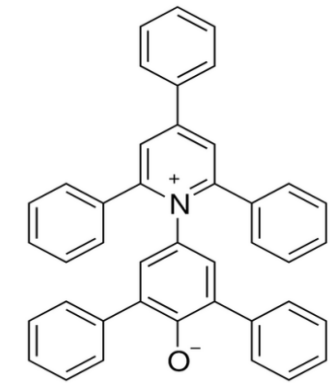
## Evidence of the physical existence of the potency

- All of these bottles contain exactly the same pigment, Reichardt's dye. The only difference is the solvent.



More polar

Less polar

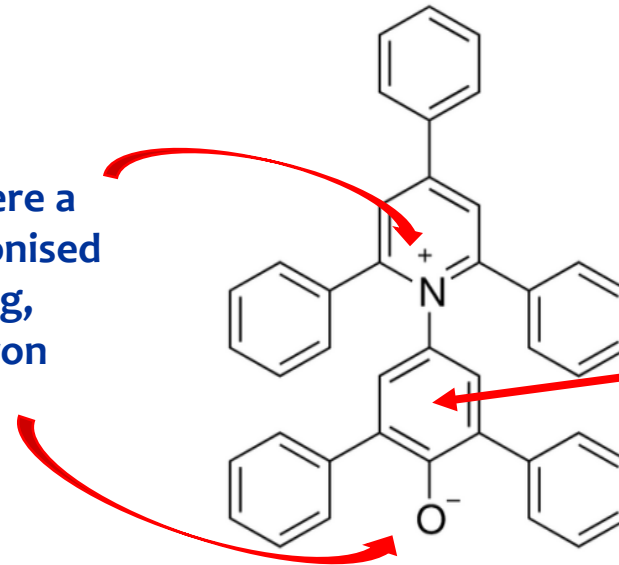


Reichardt's dye  
pyridinium N-phenoxide betaine or ET30

## Evidence of the physical existence of the potency

- Dyes which change colour depending on the polarity of the solvent are known as *solvatochromic* dyes
- This sensitivity results from the fact that solvatochromic dyes are themselves polar

The molecule contains two atoms, here a nitrogen and an oxygen, which are ionised – the nitrogen has an electron missing, whilst the oxygen has an extra electron



The ionised atoms are connected via an aromatic bridge which allows electrons to oscillate back and forth between the two centres of charge

The frequency of this oscillation depends on the polarity of the solvent.  
This frequency then determines which wavelengths of light the dye absorbs, and hence its colour.

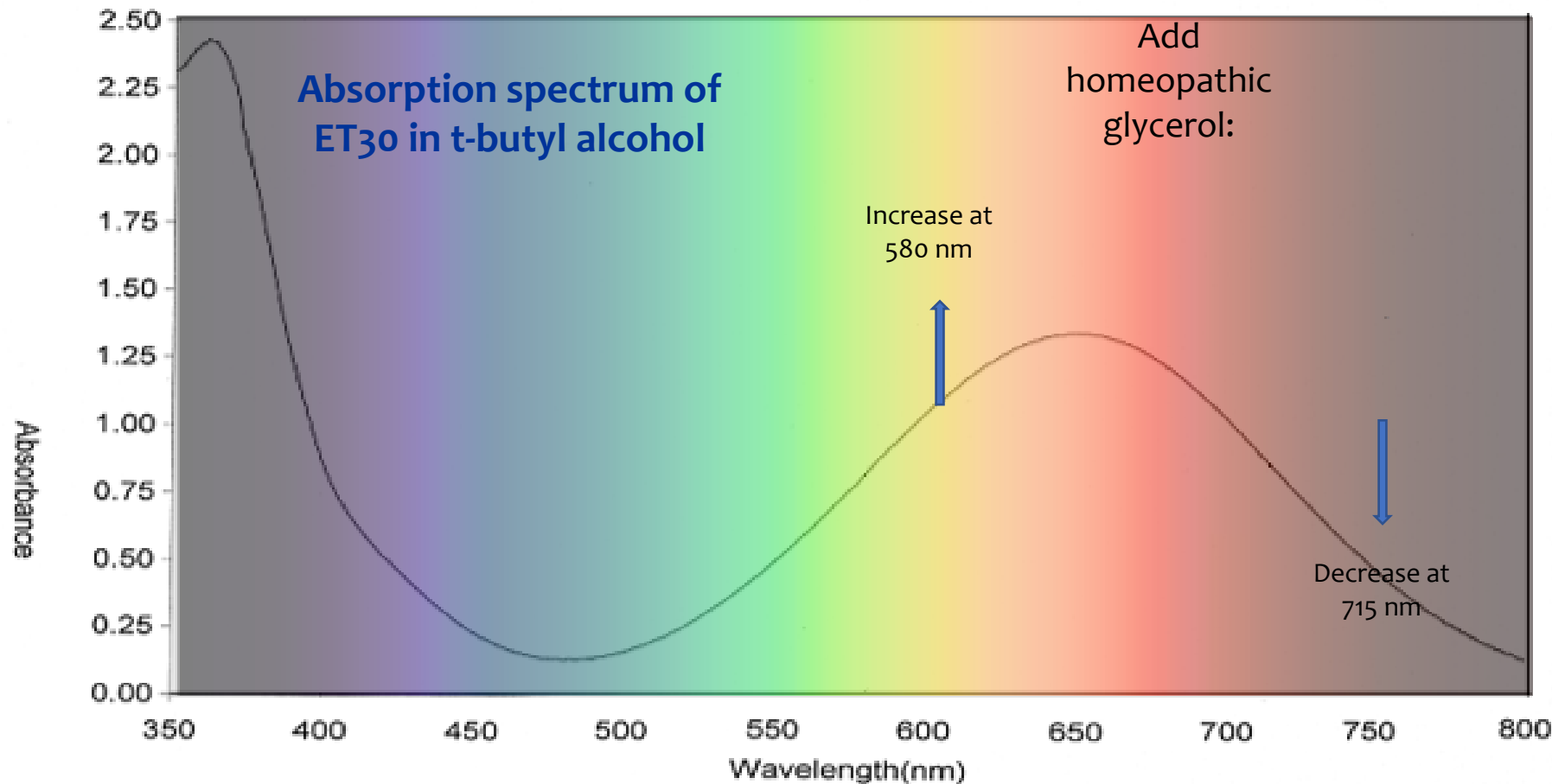
## Evidence of the physical existence of the potency

### To summarise:

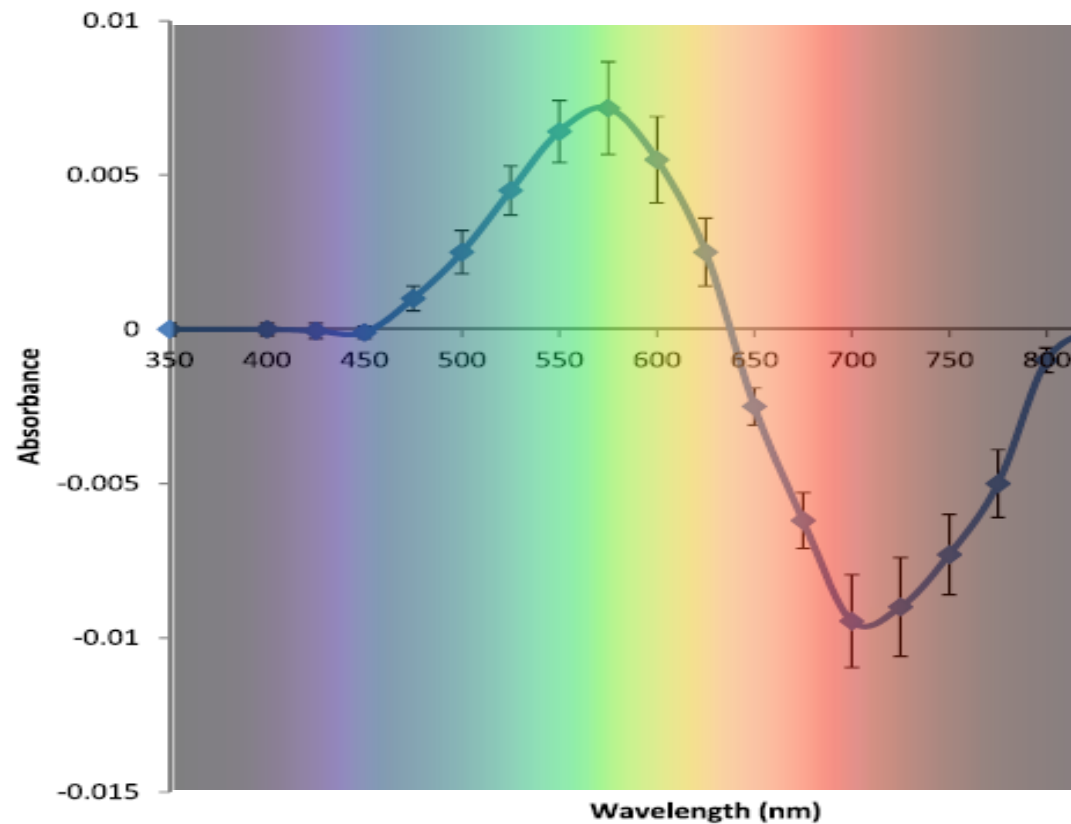
- The molecules of solvatochromic dyes behave like minuscule tuning forks, vibrating at the frequencies of light rather than the frequencies of sound. (If you could hear the colour red, it would be 41 octaves above Middle C.)
- Anything which affects the electrical environment of a solvatochromic molecule will change the frequency of its vibration, which in turn will alter its colour.



## Evidence of the physical existence of the potency



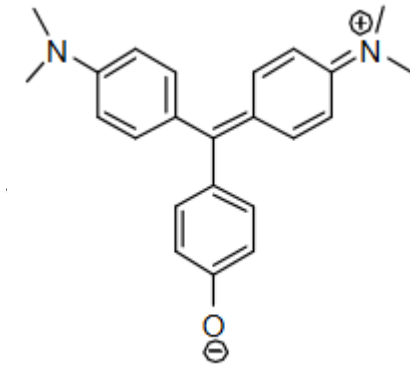
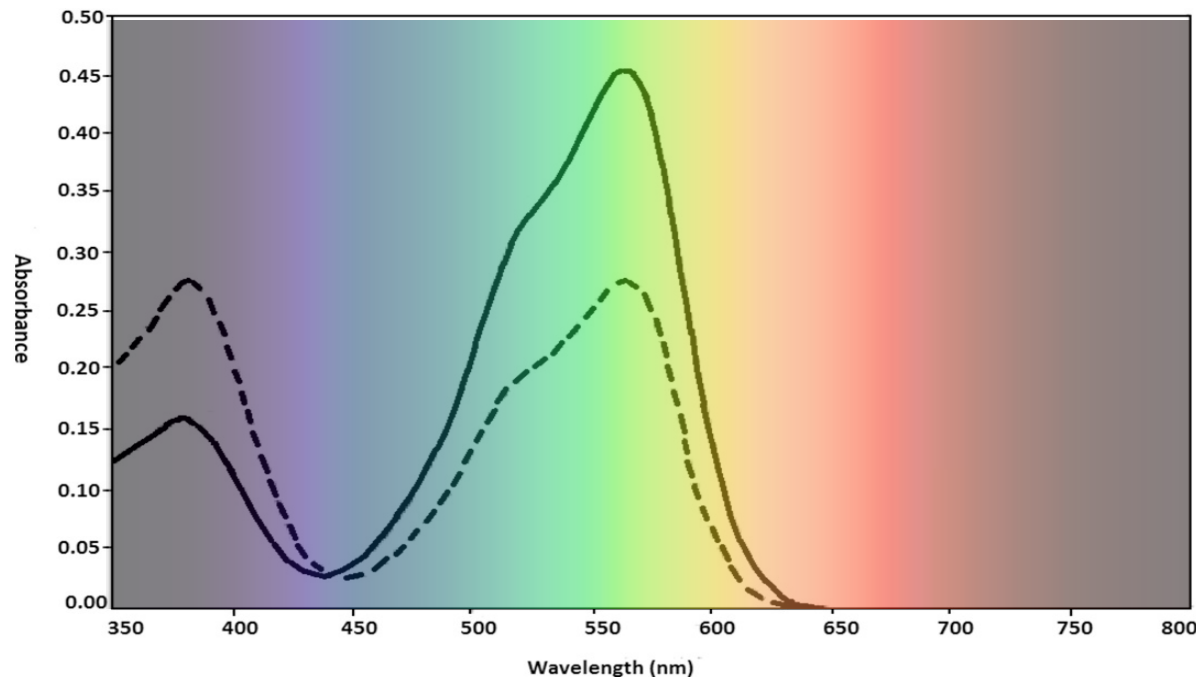
## Evidence of the physical existence of the potency



**Difference spectrum showing  
altered absorbance induced by  
potency of glycerol 50M**

## Evidence of the physical existence of the potency

- Next step was to try a different solvatochromic dye, BDF
- This produced larger changes, visible to the naked eye



Bis-dimethylaminofuchson  
(BDF)

Absorbance spectra for control  
(dashed line) and potency of  
glycerol 50M

## Evidence of the physical existence of the potency

### Further work:

- A wide variety of solvatochromic dyes were encapsulated within  $\beta$ -cyclodextrins<sup>1</sup>
- Despite now being physically separated from the solvent, the dyes continued to react to the presence of the potency in the same way as when in solution
- This strongly supports the view that the interaction is electromagnetic in nature
- The magnitude of the induced spectral changes suggest a field strength of  $\sim 1.2 \times 10^7$  V/m
- This is comparable to the typical potential difference across cell membranes

<sup>1</sup>Cartwright SJ *Homeopathic Potencies May Possess an Electric Field(-like) Component: Evidence from the Use of Encapsulated Solvatochromic Dyes*  
Homeopathy 2020; 109: 14-22

## Evidence of the physical existence of the potency - Conclusions

- Numerous experiments over several decades using a range of techniques have repeatedly demonstrated that homeopathic potencies created by serial dilution and succussion differ consistently both from each other and from unsuccussed controls
- From the outset, results have pointed to some kind of structural reorganisation of the solvent at a molecular level
- The most recent work seems to indicate that the potency takes the form of an oscillating dipole which appears to operate through electromagnetic forces



## Clinical evidence

- In 2005, *The Lancet* published a paper<sup>1</sup> claiming that a comprehensive meta-analysis of placebo-controlled homeopathic trials showed no evidence for homeopathic treatment beyond placebo. An accompanying editorial announced that this amounted to “the death of homeopathy”.
- Widely quoted by sceptics since then as providing definitive proof that homeopathy is nonsense.
- The paper was heavily relied upon by the report *Evidence Check 2: Homeopathy* by the House of Commons Science and Technology Committee, February 2010.
- *Evidence Check 2* was then relied upon by an “information paper” which attacked homeopathy, published by the Australian National Health and Medical Research Council.
- Both of these reports have been criticised as being heavily biased against homeopathy, with the Australian report in particular accused of suppressing evidence and misreporting.

<sup>1</sup>Shang A et al. Are the clinical effects of homoeopathy placebo effects? Comparative study of placebo-controlled trials of homoeopathy and allopathy *Lancet* 2005; 366: 726–32

## Clinical evidence

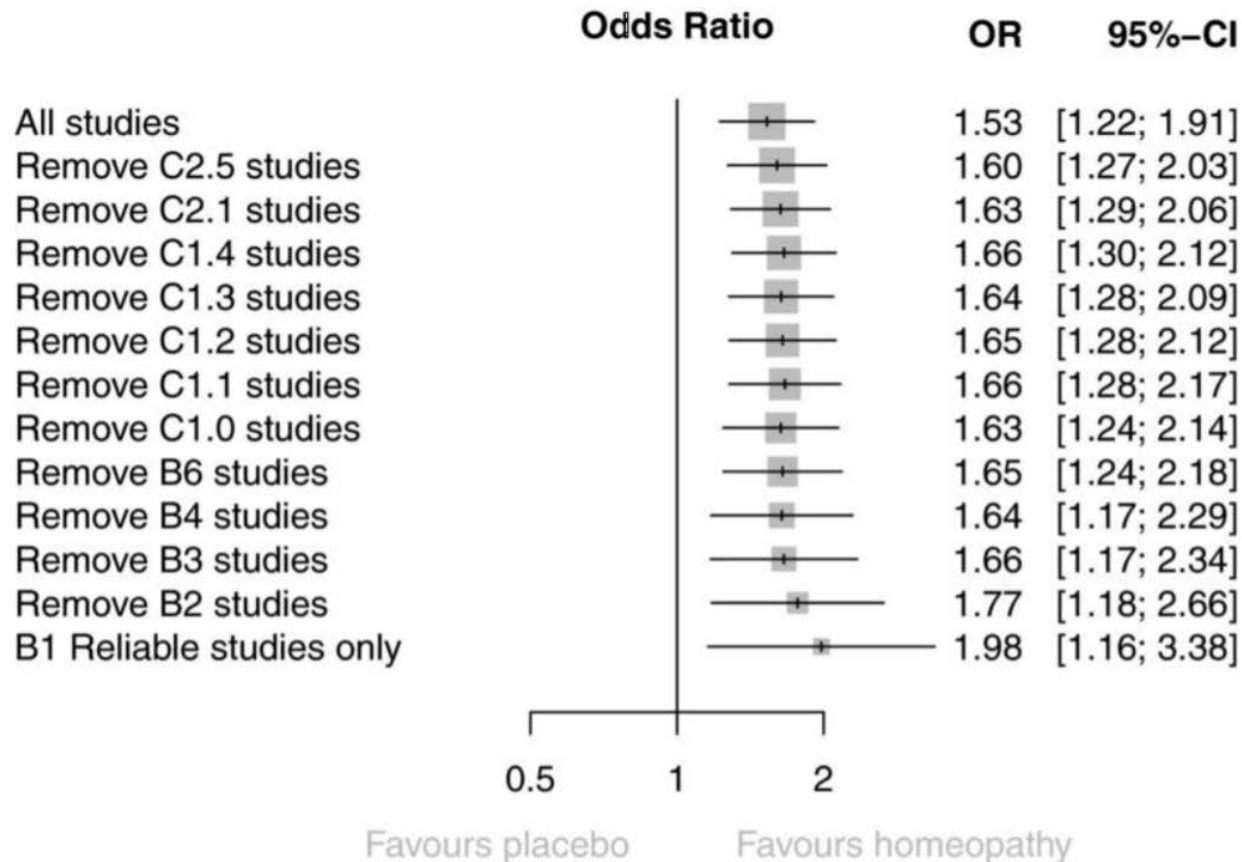
- The Shang et al. paper has received wide criticism, not least for failing to meet the recommended standards for a meta-analysis on a number of grounds.
  - Cut-off criteria for selecting studies not specified, appear to have been arbitrarily set, and changed in the course of the analysis.
  - No information given on which 8 trials were selected for the final analysis or on what basis, and the authors refused to supply this information when asked.
  - No sensitivity analysis (looking at the effects of similar calculations on different subsets of the data). Of the homeopathy trials, 21 were identified as being of “higher quality”, but there was no analysis of these.
  - Funnel plot used to establish trial “quality” – this approach has since been discredited.
  - Criteria for matching the allopathic trials were not stated, while the data in the paper itself suggested that the homeopathic and allopathic trials were not, in fact, well matched.
  - Some of the homeopathic trials were unsuitable for inclusion in the first place.

## Clinical evidence

- **Better designed meta-analyses which follow the Cochrane guidelines show significant treatment effects in favour of homeopathy, e.g. Mathie et al. (2014)<sup>1</sup>**
- **This is a very thorough piece of work and it is instructive to contrast it with Shang et al., which appears shoddy by comparison.**
- **Mathie et al. located 22 randomised, placebo-controlled trials which had investigated individualised homeopathic treatment, i.e. the normal manner in which homeopaths treat their patients**
- **The analysis showed a strong treatment effect in favour of homeopathy**

<sup>1</sup>Mathie RT et al. *Randomised placebo-controlled trials of individualised homeopathic treatment: systematic review and meta-analysis* Systematic Reviews volume 3, Article number: 142 (2014)

## Clinical evidence



**Mathie et al. – sensitivity analysis shows that removing studies of lower quality from the data progressively increases the observed effect of homeopathy**

Figure 1: Sensitivity analysis, showing progressive effect on pooled odds ratio (OR) of removing data by trials' risk-of-bias rating

## Clinical evidence

- **Papers have continued to be published since then showing positive effects of homeopathic treatment in well-designed, randomised trials.**
- **A recent example is the prospective, double-blind, placebo controlled, 3-arm multicentre trial of individualised homeopathy on stage 4 non-small cell lung cancer showing a 69% improvement in survival time (435 vs 257 days)<sup>1</sup>**
- **This was a very robust study, carried out to the highest methodological standards, published in a mainstream journal with an impact factor of 5.025**

<sup>1</sup>Frass M et al. Homeopathic Treatment as an Add-On Therapy May Improve Quality of Life and Prolong Survival in Patients with Non-Small Cell Lung Cancer: A Prospective, Randomized, Placebo-Controlled, Double-Blind, Three-Arm, Multicenter Study *Oncologist* 2020 Dec; 25(12): e1930-e1955



## To return to our detractors...

“There is no scientific case for homeopathy. **There is a great deal of good scientific evidence supporting homeopathy and the debate is far from over.** the debate is over.

“Homeopaths create walls of confusion, and superficially supported the possible claims exist, these do not negate the actual research which has been done.

“Homeopathy is the enemy of reason”, **It is the critics of homeopathy who are the enemies of reason, ignoring the evidence and basing their arguments on false claims.**



Prof Edzard Ernst



Dr Ben Goldacre



Prof Richard Dawkins

# Where next?

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it ... An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out, and that the growing generation is familiarized with the ideas from the beginning: another instance of the fact that the future lies with the youth. – Max Planck (1950)

(Often condensed to “Science progresses one funeral at a time” and referred to as Planck’s Principle)