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Epoxy Resins – From Chemistry to Clinic

Dr. Niamh O'Boyle

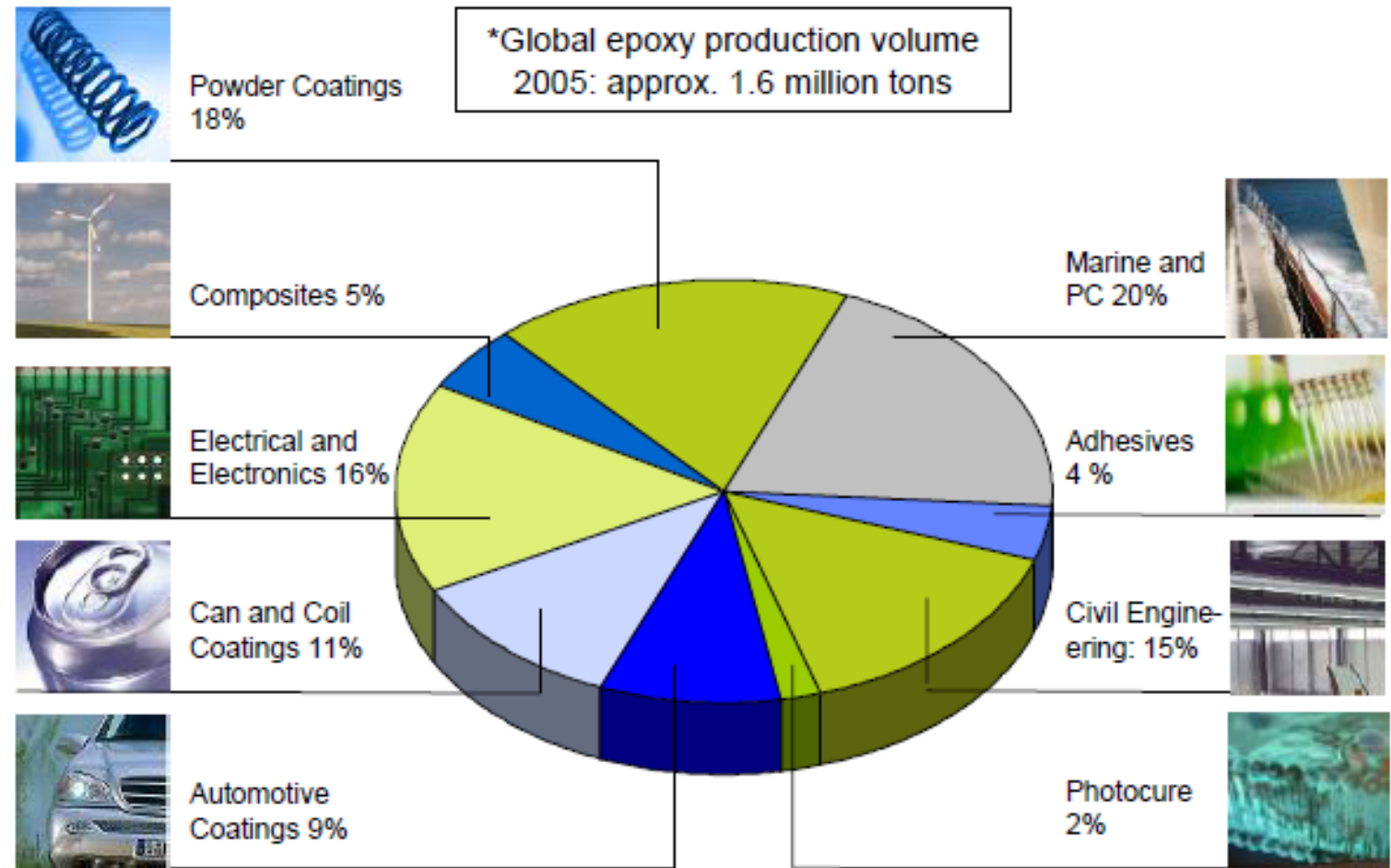
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What are Epoxy Resins?

Thermosetting
Materials

Lightweight

Flexible



Contact Allergy to Epoxy Resins

Epoxy chemicals are implicated in **both occupational and non-occupational** contact allergy.

0.9 – 2.3%



11.7 – 12.5%



Occupational Contact Allergy to Epoxy Resins

Who gets it?



Aircraft
manufacturing

56%



Marble
workers

45%



Painters

22.6%



Metal
workers

10.7%



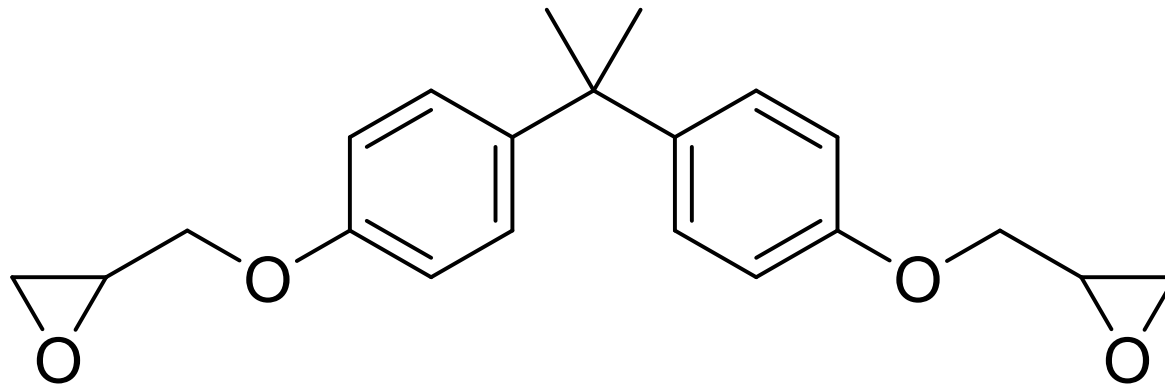
Construction
workers

9.7%

DGEBA – *diglycidyl ether of bisphenol A* or BADGE

DGEBA is included in the European baseline series for diagnosis of ACD.

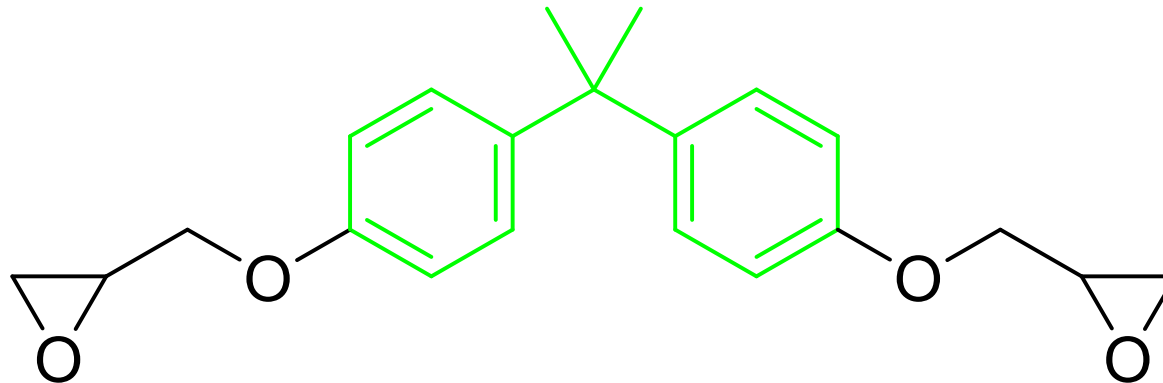
Skin sensitization potential has been investigated experimentally *in vivo* in mice and guinea pigs. DGEBA is classified as a **strong sensitizer** in both species.



Chemistry

DGEBA – *diglycidyl ether of bisphenol A*

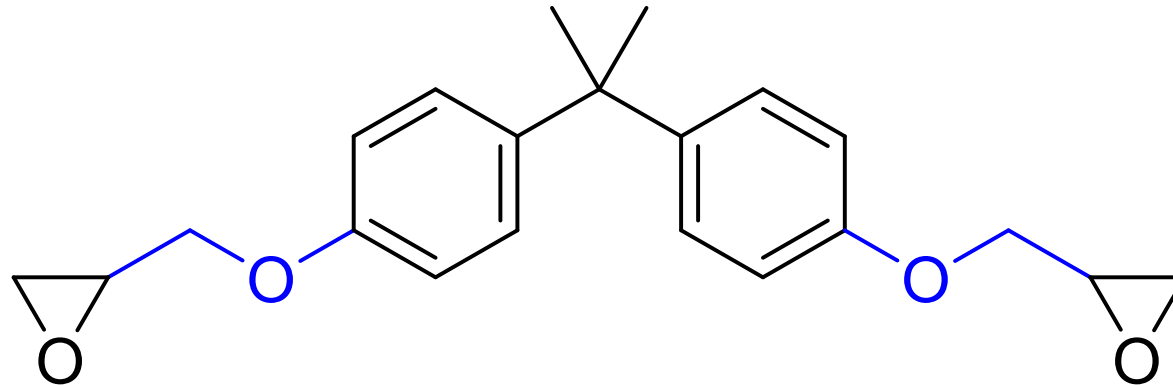
Aromatic core – imparts stability to the material



Chemistry

DGEBA – *diglycidyl ether of bisphenol A*

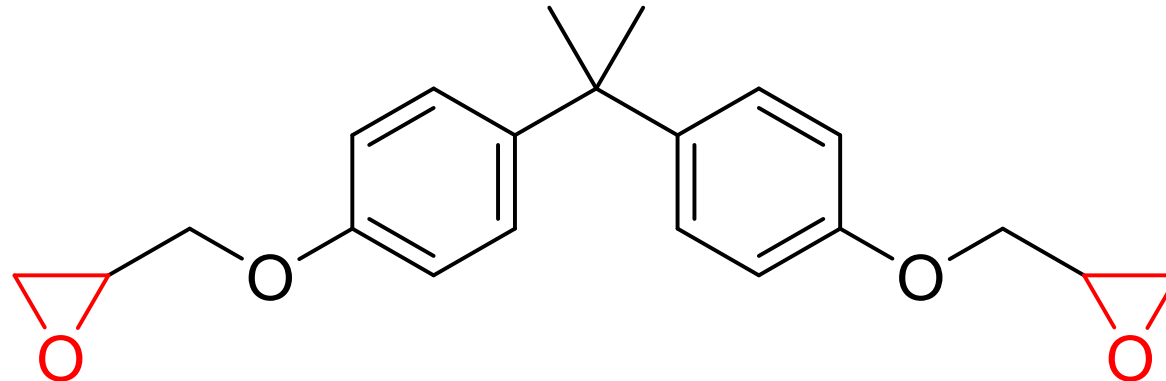
Ether oxygen and linking chain - flexibility



Chemistry

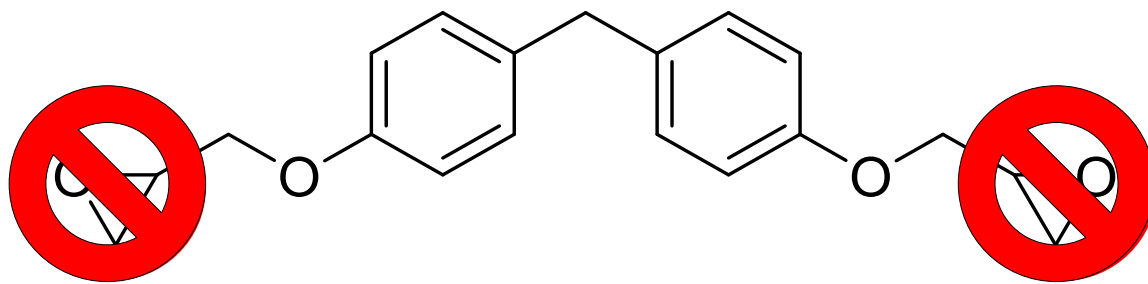
DGEBA – *diglycidyl ether of bisphenol A*

Terminal Epoxides – CRUCIAL!

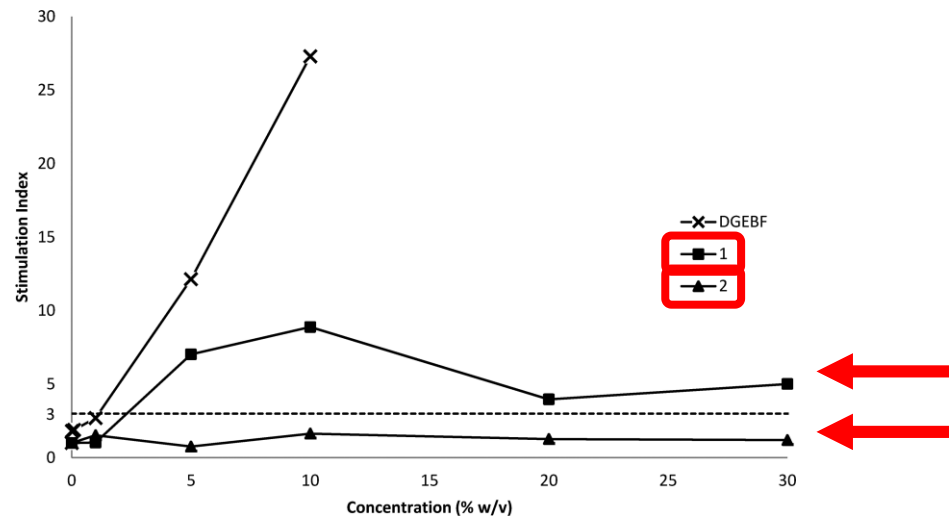


Harmful properties depend on the chemical structure

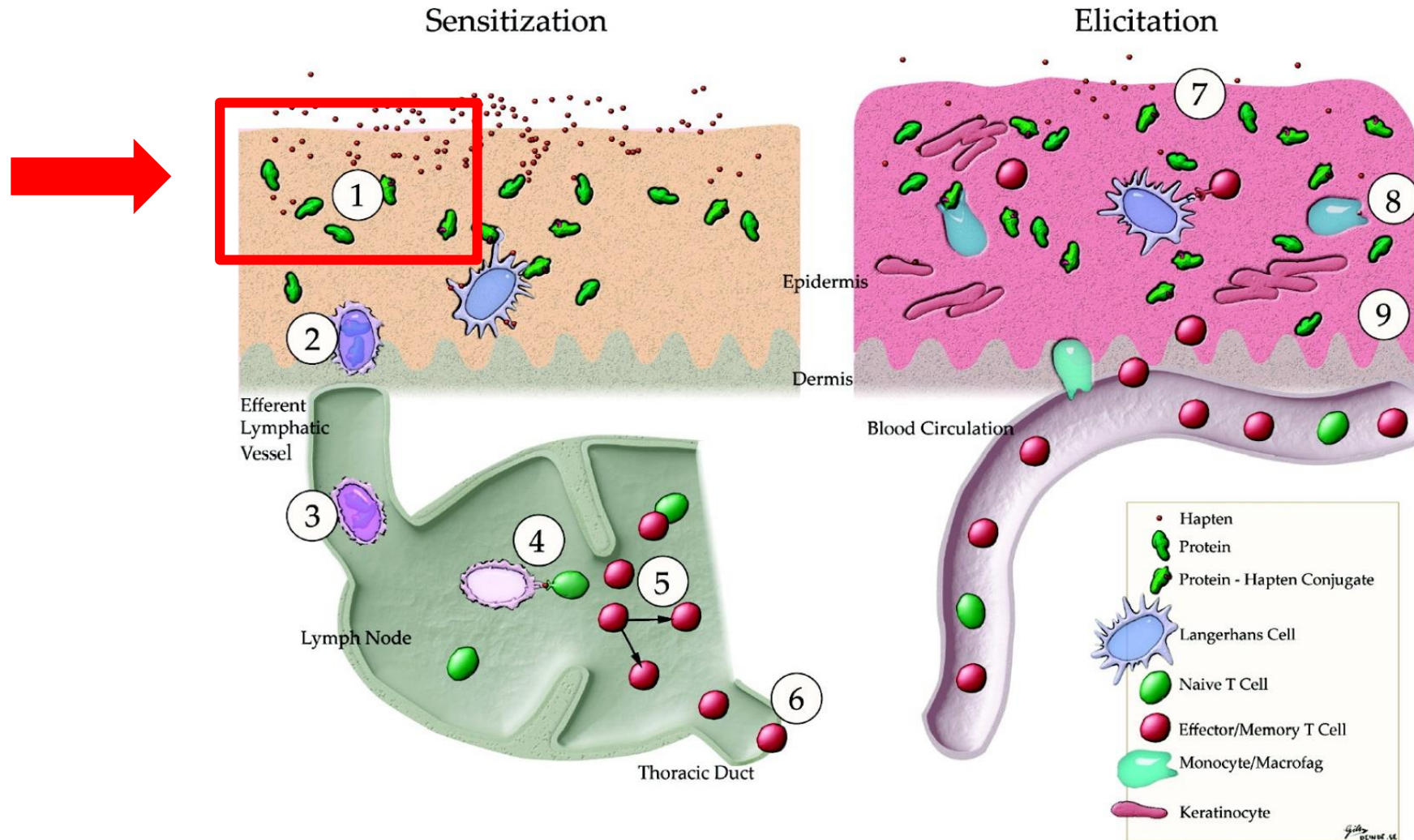
Diglycidyl ether of bisphenol F (DGEBF)



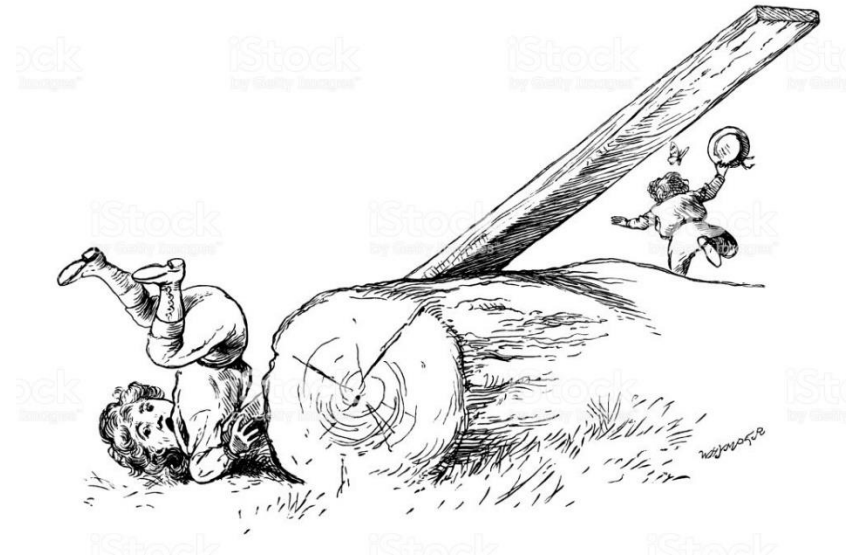
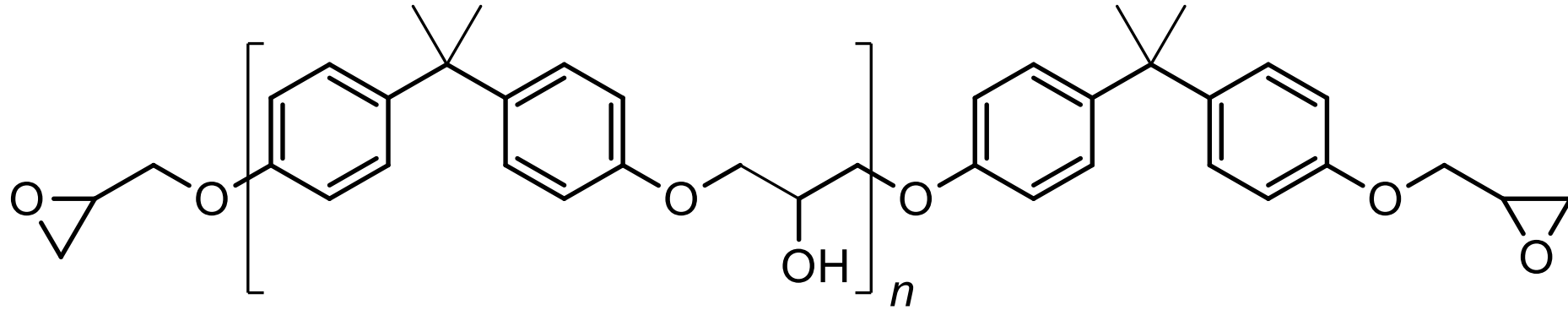
Contact allergenic
properties depend on
reactive epoxide groups



Mechanisms of Contact Allergy

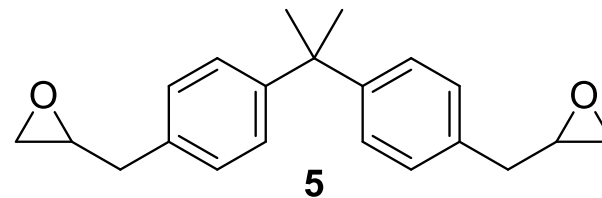
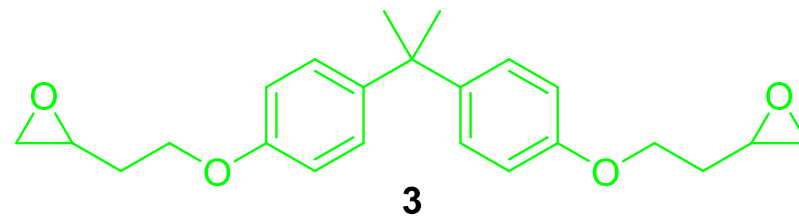
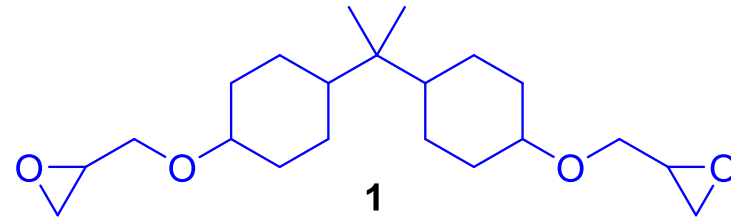
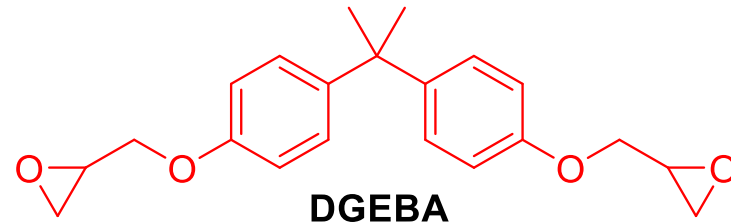


Epoxy Resin Polymers

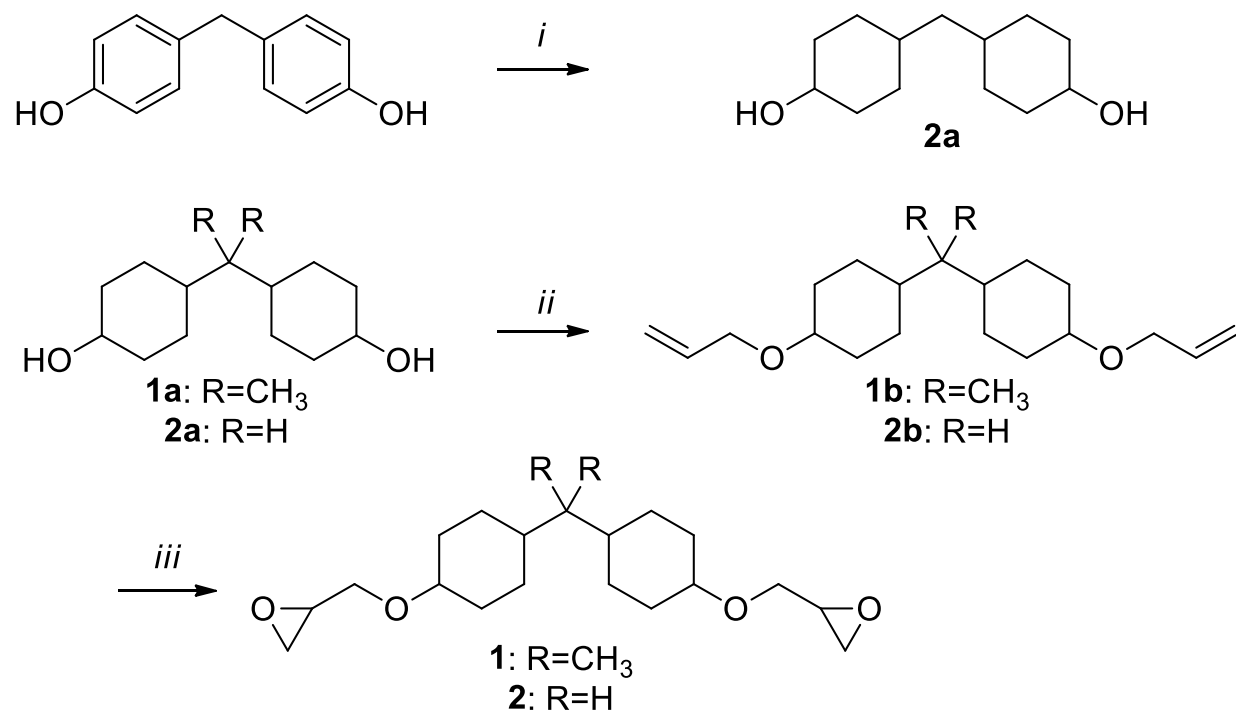


Design of New Epoxy Resins

Aim is to reduce the reactivity of the terminal epoxides



Example of Chemical Synthesis

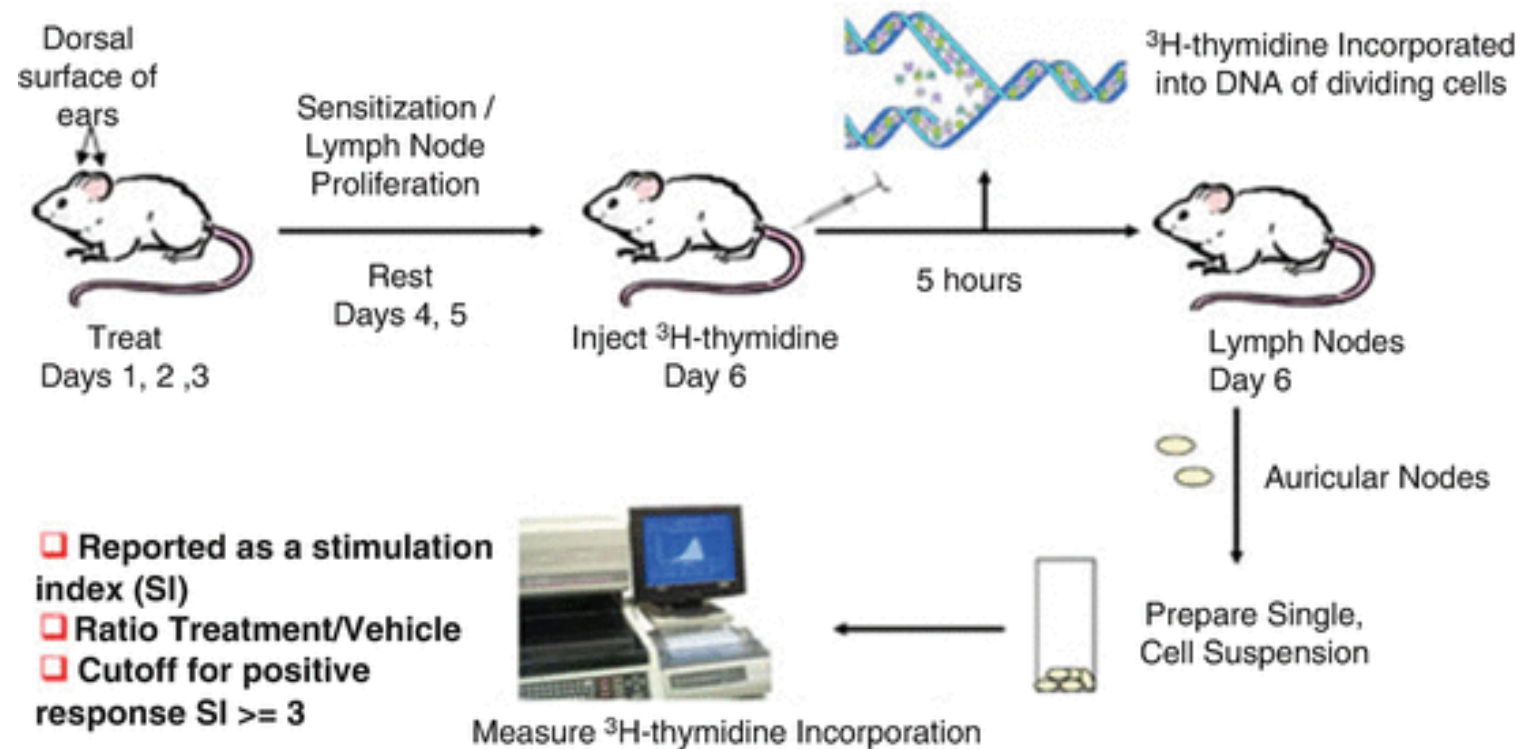


Reagents and conditions: (i) H₂, 5% Ru/C, isopropanol, 100 °C, 100 bar, until complete on TLC

(ii) NaH, THF, 0 °C, 10 mins, then CH₂CHCH₂Br, rt, 90 min, then reflux until complete on TLC

(iii) mCPBA, CHCl₃, 0 °C then rt until complete on TLC

In Vivo Local Lymph Node Assay (LLNA)



LLNA Results

EC3 values:

DGEBA (■): 0.036 M

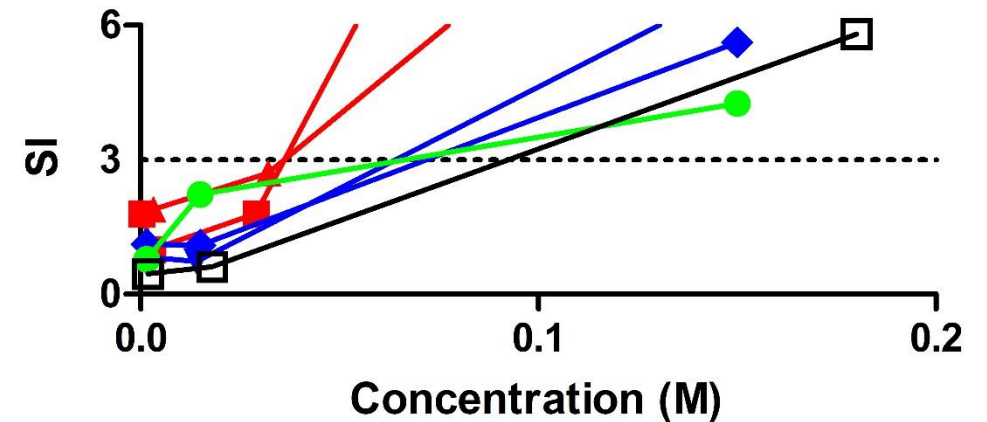
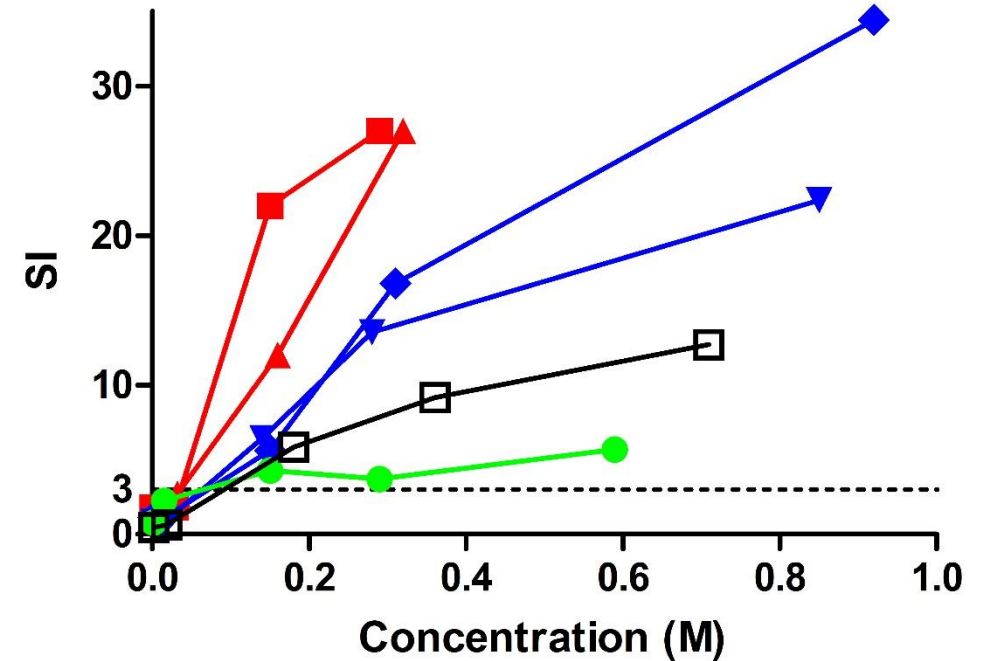
DGEBF (▲): 0.036 M

1 (▼): 0.065 M

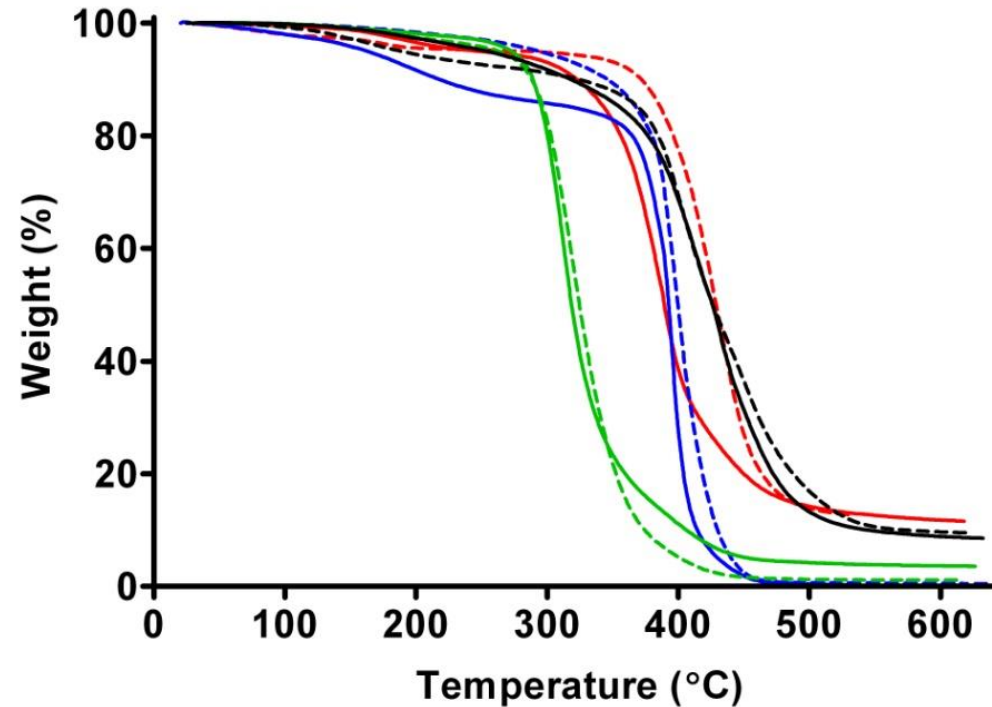
2 (◆): 0.074 M

4 (●): 0.065 M

6 (□): 0.091 M



Polymerisation Results - TGA



Thermogravimetric thermograms showing % weight loss at increasing temperatures of epoxy resins based on different epoxy resin monomers in N_2 . DGEBA and analogs: dashed lines; DGEBF and analogs: solid lines.

DGEBA (---), DGEBF (—), 1 (---), 2 (—), 3 (---), 4 (—), 5 (---), 6 (—).

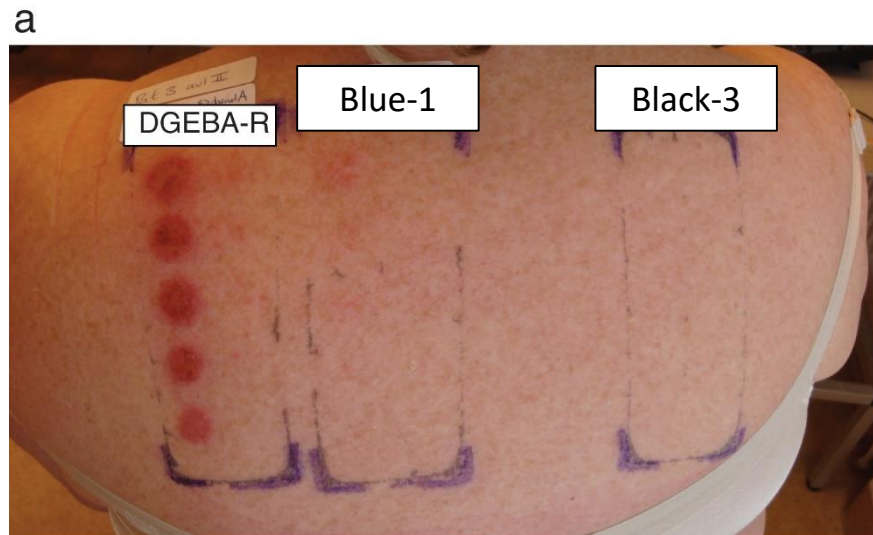
Polymerisation Results - DSC

	Glass transition temperature (°C)	Decomposition temperature (°C)
Epoxy resin based on DGEBA	43.3	427
Epoxy resin based on DGEBF	42.0	404
Epoxy resin based on 2	43.5	392
Epoxy resin based on 4	43.6	<u>323</u>

Clinical Studies

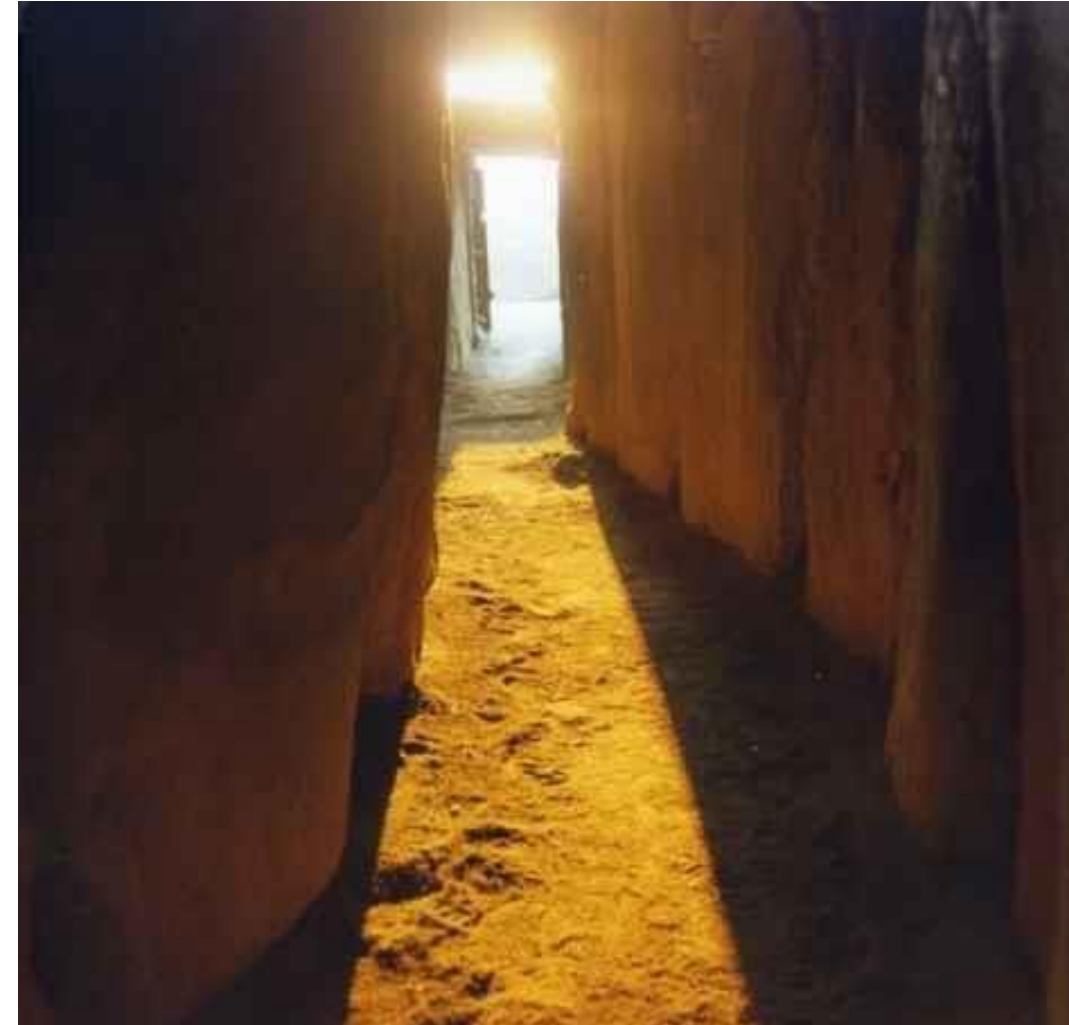
Eleven individuals with previous positive patch test reactions to epoxy resin of DGEBA

Two alternative epoxy resin monomers were patch tested in dilution series in parallel with epoxy resin of DGEBA from the baseline series (containing 92% DGEBA).



Conclusions

- Successful design and chemical synthesis of alternative epoxy resin monomers
- Reduced sensitization potency *in vivo* in LLNA
- Comparable polymerisation properties to commercially used monomers (DGEBA and DGEBF)
- No cross-reactivity in patients previously sensitized to DGEBA for one compound
- Important to consider chemistry!





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Thank You