

## List of things that can damage DNA

### *intracellular processes of metabolism*

- simple entropy<sup>1</sup>
- reactive oxygen species
- breakdown products of other molecules (for example H<sub>2</sub>O<sub>2</sub> and even formaldehyde<sup>2</sup> possible)
  - sugar breakdown
    - Drinking sugar forces your liver to convert the fructose to dangerous fats says [this summary...](#)
  - alcohol to aldehydes (highly genotoxic - to note: formaldehyde is the simplest aldehyde)

### *external exposures leading to genotoxicity*

- parts of electromagnetic spectrum - ionizing radiation, x-rays, uv light,
- hydrocarbons - benzene, Poly Aromatic Hydrocarbons (PAHs - these can also come from bbq's when fat drips onto the heat source! [Tips for a less genotoxic bbq](#) are available.)
- more complex molecules, some man-made, others produced by living organisms
  - chemicals: phenol, aminophenols, formaldehyde, aldehydes in general - some produced by our liver's metabolism of alcohol that was drunk - (caffeine?), pesticides and their breakdown products, ethidium bromide, many more
  - factors: colibactin
  - enzymes: nucleases that break up nucleic acids (RNase, DNaseI, micrococcal nucleases)
- bacterial pathogens (typhoid, heliobacter - making DNases and Ribonucleotide Reductases)
- viruses (can also be already part of your genome and are then also called 'endogenous' viruses, some of which comprise large families of repetitive DNAs, not just from external sources, when they are termed 'exogenous' viruses.)
  - These can result in integrative mutagenesis, activation of potential oncogenes or inactivation of tumor suppressor genes, and also can pick up and move around transforming oncogenes.
- mycotoxins, produced by fungi, like *Aspergillus* species. [Aflatoxin is one of the most carcinogenic substances known](#), intercalates readily into DNA where it can alkylate bases and mutate p53. It is one of the reasons for contaminated peanut product recalls. Liver metabolism of these can sometimes result in more dangerous compounds, but can also inactivate them...
- cobra venom (contains DNase - but inhibition of acetylcholine pathway more important for paralysis and killing. Possibly the DNase component of venom is primarily to aid digestion of prey!)

watch out ! while DNA repair is key, it can also fix new mutations in the genome!

also to note: damage to RNA might also be predicted to have negative consequences on genomic integrity, but large numbers of redundant molecules of active RNA species may offset such potential problems...

1) During DNA replication, the presence of naturally occurring base isomers can lead to new mutations being introduced, through their alternative base pairing capacity. Base hydrolysis can also occur spontaneously, thanks to water molecules and leaving gaps in the double helix, to result in permanent changes in the DNA sequence after repair.

2) Formaldehyde is a simple molecule,  $\text{CH}_2\text{O}$ , that was only officially recognized as a mutagen by US authorities in 2011. It is the basis of embalming fluids, and chemically is a broad spectrum cross-linker. More information about how many things contain not only it itself, but compounds that also can convert into formaldehyde (sometimes hidden in formulations of even personal care products, and sometimes even as things that may be normally ingested, or not, as in the case of toxicity from wood alcohol, containing methanol) are now added in the AGiR! site (see 'hidden formaldehyde' from the main menu)