

Alternatives to Ethidium Bromide

Ethidium Bromide

Ethidium Bromide has been used as a stain to visualise nucleic acids in agarose and polyacrylamide gels because of its high sensitivity and rapid action.

Due to its ability to enter into DNA /RNA chains it is now regarded as a possible mutagen and / or carcinogen and its use is decreasing in certain establishments.

Alternatives and Risk Assessment

There are several alternative nucleic acid stains available from a variety of manufacturers. The use of these dyes should be considered during the project risk assessment as any chemical which can react with nucleic acids could potentially act as a mutagen.

Some stains have been evaluated using the Ames I and / or the Ames II tests, however it should be borne in mind that these tests are *in vitro* and it is possible that they may exert mutagenic effects. It is good practice to prevent pregnant women working in laboratories where DNA / RNA stains are being used.

When undertaking the [risk assessment](#) the hierarchy of control is to eliminate the chemical if possible, substitute it for a less hazardous chemical, reduce the length of exposure to the chemical, or consider a means of enclosing the process and using suitable gloves or goggles.

It is also advisable to consider the effects of the light that is used to visualise the stained gel and also the disposal procedures when completing the risk assessment and SOP.

It should be borne in mind that any product that is capable of interacting with nucleic acids *in vivo* may be capable of causing genetic damage and it is best to avoid contact by wearing gloves as appropriate.

Alternative Nucleic Acid stains

The following information has been acquired via manufacturers websites. Several papers have also been produced recently looking at the toxicity and mutagenicity of the dyes in different organisms.

The choice of stain is left to the individual investigator.

A recent [study](#) evaluated several Nucleic acid stains against Ethidium Bromide for their staining effectiveness.

The following have advertised as possible replacements for EthBr with some stains claiming to have a picogram detection level.

Eva Green

This is a fluorescent dye that can be used for DNA staining. Eva Green is marketed by [GeneOn](#).

SYBR Safe or SYBR Green

These are two commonly used alternative to Ethidium Bromide is SYBR Safe which can be used in both Acrylamide and Agarose gels. SYBR Safe can be visualised using visible blue light rather than using UV light. [ThermoFisher Scientific](#) and [Sigma](#) supply a range of SYBR Safe products.

SYBR Gold

This is marketed by [ThermoFisher](#) as being their most sensitive DNA stain.

Diamond Nucleic Acid Dye

This is marketed by [Promega](#) as having similar sensitivity as SYBR Gold.

Gel Red and Gel Green

These are fluorescent dyes that can be used in Agarose gels. [Gel Red](#) is currently (2016) believed to be non-toxic and non-mutagenic. Gel Red and Gel Green are supplied in the UK by Thermo Fisher Scientific, [Cambridge Bioscience](#) and also by Sigma.

MaestroSafe Nucleic Acid dye

These are fluorescent dyes that can be used to visualise DNA and RNA. They have been evaluated using the Ames test and are judged to non-toxic.

EZ Vision Blue Light

This is a florescent dye that can be used for staining DNA. It is available from [VWR](#)

Nancy-520

This is an alternative to Ethidium Bromide that has been assessed using the Ames II test. [Sigma](#) supply the stain in the UK

The above list is not exhaustive and other stains are available from manufacturers which can be found via an internet search.

A Selection of Papers referring to toxicity / mutagenicity of DNA / Stains

1. Toxicity, mutagenicity and transport in *Saccharomyces cerevisiae* of three popular DNA intercalating fluorescent dyes.
Yeast 2015 Sep;32(9):595-606
Sayas E, García-López F, Serrano R.
2. Properties of nucleic acid staining dyes used in gel electrophoresis.
Electrophoresis 2015 Mar;36(6):941-4
Haines AM1, Tobe SS, Kobus HJ, Linacre A.
3. Are other fluorescent tags used instead of ethidium bromide safer?
Daru. 2013 Dec 19;21(1):71
Saeidnia S, Abdollahi M.
4. SYBR Gold and SYBR Green II are not mutagenic in the Ames test.
Mutat Res 2010 Jun 17;699(1-2):1-4
Kirsanov KI1, Lesovaya EA, Yakubovskaya MG, Belitsky GA.