

**MIT EHS Office Green Chemistry/Pollution Prevention Program
Ethidium Bromide Alternatives Assessment
August 2009 (revised: August 2011)**

Product	Nucleic acids visualized and method	Visual range, nm as absorb/emit (abs/em)	Gel base and application (i.e., precast or post-gel)	Sensitivity (ug/mL) or lowest dilution reported	Stability or Storage Limits	Types of visual equipment (gel documentation)	Mutagenicity, Acute Toxicity and Aquatic Toxicity	Disposal	Unit price, dose & cost per gel
Ethidium Bromide¹	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA <input checked="" type="checkbox"/> PCR	290 nm 605 nm	<input checked="" type="checkbox"/> agarose <input checked="" type="checkbox"/> acrylamide	0.2ng-0.5ng	May be stored at room temperature; indefinite storage	<input checked="" type="checkbox"/> UV Transilluminator <input checked="" type="checkbox"/> Polaroid 667 black & white	Mutagenic with S9 activation of Salmonella TA98 and TA1537 strains LD₅₀, rat (oral): 1503 mg/kg (slightly toxic) Aquatic toxicity: LC ₅₀ not available, MSDS indicates "may cause long-term adverse effects on aquatic environment"	Managed as hazardous waste	Approx. \$30 for 10mL of 10mg/mL solution; use 0.5µg/mL for agarose gel; yields 5,000 40-mL gels, \$0.006/gel.
SYBR Safe²	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA	280/502 nm 530 nm	<input checked="" type="checkbox"/> agarose <input checked="" type="checkbox"/> acrylamide <input checked="" type="checkbox"/> pre-cast <input checked="" type="checkbox"/> post-gel	Comparable to ethidium bromide	Keep away from heat and light; stable for approx. 6 months when stored at room temperature.	<input checked="" type="checkbox"/> UV Transilluminator <input checked="" type="checkbox"/> blue (vis) light transilluminator (Safelmager™ recommended) <input checked="" type="checkbox"/> laser scanner <input checked="" type="checkbox"/> Polaroid 667 black & white	Weakly mutagenic with S9 activation of Salmonella TA98 and TA1537 strains LD₅₀, rat (oral): >5,000 mg/kg (practically nontoxic)	Approved by MWRA for drain disposal, May 2005	\$53.75 for 10,000X SYBR Safe in DMSO, 400µL; 4µL for 40 mL gel = \$0.5375 per gel.

¹ Available from numerous vendors

² Invitrogen/Molecular Probes (now Life Technologies)

**MIT EHS Office Green Chemistry/Pollution Prevention Program
Ethidium Bromide Alternatives Assessment
August 2009 (revised: August 2011)**

Product	Nucleic acids visualized and method	Visual range, nm as absorb/emit (abs/em)	Gel base and application (i.e., precast or post-gel)	Sensitivity (ug/mL) or lowest dilution reported	Stability or Storage Limits	Types of visual equipment (gel documentation)	Mutagenicity, Acute Toxicity and Aquatic Toxicity	Disposal	Unit price, dose & cost per gel
						with SYBR Safe filter (S37100) or Molecular Probes SYPRO filter (S6656) or Kodak Wratten #9 filter	Aquatic toxicity: LC ₅₀ >750mg/L		
GelRed³	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA	275 nm 600 nm	<input checked="" type="checkbox"/> agarose <input checked="" type="checkbox"/> acrylamide <input checked="" type="checkbox"/> pre-cast (agarose) <input checked="" type="checkbox"/> post-gel (both)	1-3ug/mL; visualizes DNA doses as low as 25ng.	Store in water at room temperature or at 4°C	<input checked="" type="checkbox"/> UV Transilluminator <input checked="" type="checkbox"/> similar spectra as ethidium bromide, therefore can use same visualization settings	Weakly mutagenic at 18.5 µg/mL with S9 activation of Salmonella TA98 LD₅₀, rat (oral): not provided on MSDS Cell membrane staining: did not cross HeLa cell membranes after 30 minutes incubation Aquatic toxicity: LC ₅₀ >750mg/L	Approved by MWRA for drain disposal, April 2010	Available as 0.5mL (500µL) of 10,000X concentrate; working dilution is 1-3µg/mL for 167-500 minigels \$100-\$105 (\$0.20-\$0.63/gel)
GelGreen³	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA	250-300/500nm ~525 nm	<input checked="" type="checkbox"/> agarose <input checked="" type="checkbox"/> acrylamide	1-3µg/mL	Store in water at room	<input checked="" type="checkbox"/> UV Transilluminator (254 nm)	Non-mutagenic from 0.4µg/mL	Approved by MWRA for drain	500µL 10,000X concentrate

³ Biotium

**MIT EHS Office Green Chemistry/Pollution Prevention Program
Ethidium Bromide Alternatives Assessment
August 2009 (revised: August 2011)**

Product	Nucleic acids visualized and method	Visual range, nm as absorb/emit (abs/em)	Gel base and application (i.e., precast or post-gel)	Sensitivity (ug/mL) or lowest dilution reported	Stability or Storage Limits	Types of visual equipment (gel documentation)	Mutagenicity, Acute Toxicity and Aquatic Toxicity	Disposal	Unit price, dose & cost per gel
	(GelRed recommended for ssDNA and RNA)		<p>– not recommended due to slow diffusion of dye</p> <p><input checked="" type="checkbox"/> pre-cast</p> <p><input checked="" type="checkbox"/> post-gel</p>		temperature or at 4°C	<input checked="" type="checkbox"/> 488nm laser-based gel scanner	<p>to 18.5 µg/mL in Salmonella TA98 and TA1537 strains, w/ and w/o S9 activation.</p> <p>LD₅₀, rat (oral): not provided on MSDS</p> <p>Cell membrane staining: did not cross HeLa cell membranes after 30 minutes incubation</p> <p>Aquatic toxicity: LC₅₀>750mg/L</p>	disposal, April 2010	<p>in DMSO</p> <p>1-3µg/mL for 167-500 minigels</p> <p>\$90-\$100 (\$0.18-\$0.60/gel);</p>
MegaFluor⁴	<p><input checked="" type="checkbox"/> dsDNA</p> <p>-added directly to DNA sample, not gel or buffer</p> <p>-not advised for denatured DNA</p>	Similar absorption and emission spectra as ethidium bromide	<p><input checked="" type="checkbox"/> agarose</p> <p><input checked="" type="checkbox"/> post-gel (agarose)</p>	<p>Can run at 3pg-5pg (picograms)</p> <p>Can visualize DNA doses less than 10ng if samples are</p>	Store 10X gel at 4°C	<p><input checked="" type="checkbox"/> UV transilluminator</p> <p><input checked="" type="checkbox"/> similar spectra as ethidium bromide, therefore can use same visualization settings</p>	Manufacturer claims molecule is large and does not cross cell membrane. Indicated testing performed on epithelial cells	Not present in the gel running buffer; buffer may be disposed by drain.	<p>\$225 for 500-1500 gels = \$0.15-\$0.45 per gel</p> <p><u>Dose:</u> MegaFluor to DNA, 1:10</p>

⁴ GenTaur

**MIT EHS Office Green Chemistry/Pollution Prevention Program
Ethidium Bromide Alternatives Assessment
August 2009 (revised: August 2011)**

Product	Nucleic acids visualized and method	Visual range, nm as absorb/emit (abs/em)	Gel base and application (i.e., precast or post-gel)	Sensitivity (ug/mL) or lowest dilution reported	Stability or Storage Limits	Types of visual equipment (gel documentation)	Mutagenicity, Acute Toxicity and Aquatic Toxicity	Disposal	Unit price, dose & cost per gel
				first incubated at 60°C.			showed no mutagenicity. LD₅₀, rat(oral): not stated Aquatic toxicity: LC ₅₀ not stated	No formal MWRA approval; meets or exceeds criteria for SYBR Safe.	MegaFluor to DNA marker, 2:10 MegaFluor to genomic DNA, 4:10 1.5 mL = 1,500 dsDNA gels @10µL (100 samples per 1.5mL kit)
SafeWhite⁹	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA	320 nm 480 nm	<input checked="" type="checkbox"/> agarose	0.1ng-0.3ng	Store 6X in water at 4°C	Same as for ethidium bromide	Non-mutagenic in Salmonella TA98 and TA1537 strains, w/ and w/o S9 activation. LD₅₀, rat(oral): not stated Aquatic toxicity: LC ₅₀ not stated	Approved by MWRA for drain disposal, April 2010	6X in water; 1mL, \$58 <u>Dose:</u> 5µL per 100 mL agarose = \$0.29 per gel
SafeRed⁴	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA	490 nm 630 nm	<input checked="" type="checkbox"/> agarose	0.3ng-0.8ng	Store 6X in water at 4°C	Same as for ethidium bromide	Non-mutagenic in Salmonella TA98 and TA1537	Approved by MWRA for drain disposal, April 2010	6X in water; 1 mL, \$58 <u>Dose:</u> 5µL per 100 mL

⁵ Applied Biological Materials

**MIT EHS Office Green Chemistry/Pollution Prevention Program
Ethidium Bromide Alternatives Assessment
August 2009 (revised: August 2011)**

Product	Nucleic acids visualized and method	Visual range, nm as absorb/emit (abs/em)	Gel base and application (i.e., precast or post-gel)	Sensitivity (ug/mL) or lowest dilution reported	Stability or Storage Limits	Types of visual equipment (gel documentation)	Mutagenicity, Acute Toxicity and Aquatic Toxicity	Disposal	Unit price, dose & cost per gel
							strains, w/ and w/o S9 activation. LD₅₀, mouse subcutaneous: 16mg/kg Aquatic toxicity: LC ₅₀ not stated		agarose = \$0.29 per gel
SafeGreen⁴	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA	290 nm 490 nm	<input checked="" type="checkbox"/> agarose	0.2ng-0.6ng	Store 6X in water at 4°C	Same as for ethidium bromide	Non-mutagenic in Salmonella TA98 and TA1537 strains, w/ and w/o S9 activation. LD₅₀, mouse subcutaneous: 250 mg/kg Aquatic toxicity: LC ₅₀ not stated	Approved by MWRA for drain disposal, April 2010.	6X in water; 1 mL, \$58 <u>Dose:</u> 5µL per 100 mL agarose= \$0.29 per gel
GelStar⁶	<input checked="" type="checkbox"/> dsDNA <input checked="" type="checkbox"/> ssDNA <input checked="" type="checkbox"/> RNA	493 nm 527 nm	<input checked="" type="checkbox"/> agarose <input checked="" type="checkbox"/> acrylamide <input checked="" type="checkbox"/> pre-cast (agarose)	20pg for dsDNA; 25pg for ssDNA; 10pg for RNA.	Lasts 12 months when stored at -20°C.	302nm or 312 nm filter for UV transilluminator GelStar filter for photographs	Mutagenicity testing data not provided LD₅₀, rat(oral): not stated	Treat as potential mutagen per direction of product maker.	10,000X in DMSO, \$158 for 2x250µL <u>Dose:</u> DNA, 4µL per

⁶ Cambrex

**MIT EHS Office Green Chemistry/Pollution Prevention Program
Ethidium Bromide Alternatives Assessment
August 2009 (revised: August 2011)**

Product	Nucleic acids visualized and method	Visual range, nm as absorb/emit (abs/em)	Gel base and application (i.e., precast or post-gel)	Sensitivity (ug/mL) or lowest dilution reported	Stability or Storage Limits	Types of visual equipment (gel documentation)	Mutagenicity, Acute Toxicity and Aquatic Toxicity	Disposal	Unit price, dose & cost per gel
			<input checked="" type="checkbox"/> post-gel				Aquatic toxicity: LC ₅₀ not stated		40mL gel = 125 gels@\$1.27 per gel RNA, 8μL per 40mL gel = 62.5 gels@ \$2.53 per gel.