

PLANT GROWTH REGULATORS

The importance of plant growth regulators in plant tissue culture is well documented. *Phyto*Technology offers a broad range of plant growth regulators specifically tested for plant cell culture. Each product is assayed for physical and chemical characteristics then is biologically tested following the criteria established for powdered media. Each auxin is tested for enhancement of callus growth and/or root initiation *in vitro*. Each cytokinin is tested for stimulation of shoot production.

PLANT GROWTH REGULATORS ARE FOR LABORATORY USE, PLANT TISSUE CULTURE MEDIA PREPARATION, AND PLANT RESEARCH PURPOSES ONLY. THEY ARE NOT FOR USE AS PLANT GROWTH REGULATORS ON DEVELOPED PLANTS.

THEY ARE NOT FOR DRUG OR HOUSEHOLD USE.

PRODUCT USE

Auxins: Auxins are generally used in plant cell culture at a concentration range of 0.01-10.0 mg/L. When added in appropriate concentrations they may regulate cell elongation, tissue swelling, cell division, formation of adventitious roots, inhibition of adventitious and axillary shoot formation, callus initiation and growth, and induction of embryogenesis.

Cytokinins: Cytokinins are generally used in plant cell culture at a concentration range of 0.1-10.0 mg/L. When added in appropriate concentrations they may regulate cell division, stimulate auxiliary and adventitious shoot proliferation, regulate differentiation, inhibit root formation, activate RNA synthesis, and stimulate protein and enzyme activity.

Gibberellins: Gibberellins are generally used to promote stem elongation, flowering, and breaking dormancy of seeds, buds, corms, and bulbs. There are over 90 forms of gibberellins, but GA₃ is the most commonly used form. Compounds like paclobutrazol and ancymidol inhibit the synthesis of gibberellins.

Abscisic Acid: Abscisic Acid (ABA) plays a role in dormancy development in embryos, buds and bulbs, and in leaf abscission.

When used in tissue culture, ABA inhibits the growth of shoots and the germination of embryos. Fluridone may inhibit ABA synthesis.

Polyamines: Polyamines are compounds that occur in high levels within plants and are used in tissue culture media at concentrations of 10-1000 mM. Polyamines may enhance regeneration of roots, shoots and embryos, delay or prevent senescence, and regulate flowering.

METHODS OF PREPARATION

To prepare a 1 mg/mL stock solution: Add 100 mg of the plant growth regulator to a 100 mL volumetric flask or other glass container. Add 3-5 mL of solvent to dissolve the powder. Once completely dissolved, bring to volume with distilled/ deionized water. Stirring the solution while adding water is recommended to keep the material in solution. Store the stock solution as recommended in the tables. One mL of the stock solution in 1 liter of medium will yield a final concentration of 1.0 mg/L of the plant growth. (See conversion tables).

$$\frac{\text{Desired Hormone Concentration}}{\text{Stock Solution Concentration}} \times \text{Medium Volume} = \text{Volume of Stock Solution Required}$$

STOCK SOLUTION DILUTION CHART

To use this chart:

1. Determine the final concentration of the hormone/ vitamin etc. desired in the culture medium. In column A, locate the final concentration desired under the heading corresponding to the quantity of medium you will prepare.
2. Once you have located the desired final concentration then go across the chart to column B to determine the concentration of stock solution to prepare.
3. Find the volume of stock solution to use to achieve the final desired concentration in the medium in column C.

B Concentration of Stock Solution	C Amount to use (mL)	A Concentration of Final Solution (mg/L)				
		250 mL	500 mL	1 L	2 L	10 L
0.01 mg/mL	0.1	0.004	0.002	0.001	0.0005	0.0001
	0.5	0.02	0.01	0.005	0.025	0.005
	1.0	0.04	0.02	0.01	0.005	0.001
	10.0	0.4	0.2	0.1	0.05	0.01
0.1 mg/mL	0.1	0.04	0.02	0.01	0.005	0.001
	0.5	0.2	0.1	0.05	0.25	0.05
	1.0	0.4	0.2	0.1	0.05	0.01
	10.0	4.0	2.0	1.0	0.5	0.1
1.0 mg/mL	0.1	0.4	0.2	0.1	0.05	0.01
	0.5	2.0	1.0	0.5	0.25	0.05
	1.0	4.0	2.0	1.0	0.5	0.1
	10.0	40.0	20.0	10.0	5.0	1.0

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B Concentration of Stock Solution	C Amount to use (mL)	A Concentration of Final Solution (mg/L)				
		250 mL	500 mL	1 L	2 L	10 L
10.0 mg/mL	0.1	4.0	2.0	1.0	0.5	0.1
	0.5	20.0	10.0	5.0	2.5	0.5
	1.0	40.0	20.0	10.0	5.0	1.0
	10.0	400.0	200.0	100.0	50.0	10.0

PGR Class	Product Name	Product Number	Function in Plant Tissue Culture
Auxins	Indole-3-Acetic Acid Indole-3-Butyric Acid Indole-3-Butyric Acid, K-Salt α -Naphthaleneacetic Acid α -Naphthaleneacetic Acid, K-Salt 2,4-D (Solutions) ρ -Chlorophenoxyacetic acid Picloram Dicamba	I885/I364 I538/I460 I530 N600/N605 N610 D295/D301 C213 P717 D159/D165	Adventitious root formation (high concentration) Adventitious shoot formation (low concentration) Induction of somatic embryos Cell Division Callus formation and growth Inhibition of axillary buds Inhibition of root elongation
Cytokinins	6-Benzylaminopurine 6-(γ,γ -Dimethylallylamino)purine (2iP) 2iP-2HCl Kinetin Thidiazuron (TDZ) N-(2-Chloro-4-pyridyl)-N-phenylurea Zeatin Zeatin Riboside	B800/B130 D525/D217 D341 K750/K483 T888 C279 Z125/Z860 Z899/Z875	Adventitious shoot formation Inhibition of root formation Promotes cell division Modulates callus initiation and growth Stimulation of axillary bud breaking and growth Inhibition of shoot elongation Inhibition of leaf senescence
Gibberellins	Gibberellic Acid (GA ₃) GA _{4/7}	G500/G362 G358	Stimulates shoot elongation Release seeds, embryos, and apical buds from dormancy, Inhibits adventitious root formation
Abscisic Acid	Abscisic Acid	A102	Stimulates bulb and tuber formation Stimulates the maturation of embryos Promotes the start of dormancy, leaf abscission
Polyamines	Putrescine Spermidine	P733 S837	Promotes adventitious root formation Promotes somatic embryogenesis Promotes shoot formation
Antimitotics	Colchicine Oryzalin Trifluralin	C226 O630 T828	Binds to the tubulin dimers during cell division thus preventing the formation of spindle fibers; this results in doubled chromosomes
Dwarfing Agents/ “Anti-GA’s”	Ancymidol CCC Paclobutrazol Trinexapac-Ethyl	A123 C207 P687 T761	Interferes with gibberellin synthesis or activity Reduces internodal elongation Promotes tuber, corm, and bulb formation

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PLANT GROWTH REGULATORS
CONCENTRATION/ MOLARITY (µM) CONVERSIONS AND HANDLING RECOMMENDATIONS

Prod. No	Growth Regulator	Mol. Wt.	CAS No.	mg/L to PGR µM Conversion ¹ (See explanation below table)						Solvent ²	Dilute In	Store Prod.	Store Stock Soln.	Sterilize By	Typical Working Conc. (mg/L)
				0.1	0.3	0.5	0.7	0.9	1.0						
A102	ABA	264.3	1437545-2	0.38	1.1	1.9	2.65	3.4	3.8	KOH	Water	F	F	CA/F	0.1-10.0
A120	Adenine	135.1	73-24-5	0.74	2.2	3.7	5.18	6.7	7.4	1 N HCl	Water	RT	C	CA	50-250
A545	Adenine Hemisulfate	404.4	321-30-2	0.25	0.7	1.2	1.73	2.2	2.5	Water	Water	RT	C	CA	50-250
A123	Ancymidol	256.3	12771-68-5	0.39	1.2	2	2.73	3.5	3.9	DMSO	N/A	C	F	CA/F	1.0-10.0
A147	Auxindole™	269.9	N/A	0.37	1.1	1.8	2.59	3.3	3.7	EtOH	N/A	F	F	F	0.003-3.0
B148	4-Bromophenoxy-acetic Acid	231.1	1878-91-7	0.43	1.3	2.2	3.02	3.9	4.3	KOH	Water	RT	C	F	0.01-5.0
B155	Bromoxynil	276.9	1689-84-5	0.36	1.1	1.8	0.25	3.3	3.6	DMSO	N/A	RT	F	F	—
B151	N6-Benzoyladenine	239.2	4005-49-6	0.42	1.3	2.1	2.94	3.8	4.2	DMSO	N/A	C	F	F	0.1-10.0
B202	BPA	309.4	2312-73-4	0.32	1	1.6	2.26	2.9	3.2	EtOH	N/A	F	F	CA/F	0.1-5.0
B800	BA	225.3	1214-39-7	0.44	1.3	2.2	3.11	4	4.4	KOH	N/A	RT	C	CA	0.1-5.0
B130	BA Solution, 1 mg/mL	225.3	1214-39-7	0.44	1.3	2.2	3.11	4	4.4	N/A	Water	C	C	CA	0.1-5.0
C207	CCC	158.1	999-81-5	0.63	1.9	3.2	4.43	5.7	6.3	Water	Water	RT	C	CA	Up to 500
C213	4-CPA	186.6	122-88-3	0.54	1.6	2.7	3.75	4.8	5.4	EtOH	N/A	RT	C	CA	0.1-10.0
C279	4-CPPU	247.7	68157-60-8	0.4	1.2	2	2.82	3.6	4	DMSO	N/A	C	C	F	0.001-1.0
C283	t-Cinnamic Acid	148.2	140-10-3	0.68	2	3.4	4.72	6.1	6.7	KOH	Water	RT	C	CA	0.1-10.0
C226	Colchicine	399.4	64-86-8	0.25	0.8	1.3	1.75	2.3	2.5	Water	Water	RT	C	F	—
D159	Dicamba	221	1918-00-9	0.45	1.4	2.3	3.17	4.1	4.5	EtOH	N/A	C	C	CA	0.01 to 10.0
D297	Dikegulac	274.3	18467-77-1	0.36	1.1	1.8	2.52	3.2	3.6	EtOH	N/A	C	C	F	0.05-10.0
D295	2,4-D Solution, 1 mg/mL	221	94-75-7	0.45	1.4	2.3	3.17	4.1	4.5	N/A	Water	C	C	CA	0.01-5.0
D309	2,4-D Solution, 10 mg/mL	221	94-75-7	0.45	1.4	2.3	3.17	4.1	4.5	N/A	Water	C	C	CA	0.01-5.0
D525	2iP	203.2	2365-40-4	0.49	1.5	2.5	3.44	4.4	4.9	KOH	Water	F	F	CA	1.0-30.0
D217	2iP Solution, 1 mg/mL	203.2	2365-40-4	0.49	1.5	2.5	3.44	4.4	4.9	N/A	Water	F	F	CA	1.0-30.0
D341	2iP•2HCl	276.2	N/A	0.36	1.1	1.8	2.5	3.3	3.6	Water	Water	F	F	CA	1.0-30.0
E348	Ethephon	144.5	16672-87-0	0.69	2.1	3.5	4.84	6.2	6.9	Water	Water	RT	C	F	0.01-10.0
F357	Fluridone	329.3	59756-60-4	0.30	0.9	1.5	2.13	2.7	3.0	DMSO	N/A	C	C	F	—
F376	Flurprimidol	312.3	56425-91-3	0.32	1	1.6	2.24	2.9	3.2	EtOH/DMSO	N/A	C	C	F	0.01-5.0
G345	Glyphosate	169.1	1071-83-6	0.59	1.8	3	4.13	5.3	5.9	KOH	Water	RT	C	F	0.01-5.0
G500	GA ₃	346.4	77-06-5	0.29	0.9	1.4	2.02	2.6	2.9	EtOH	N/A	RT	C	CA/F	0.01-5.0
G362	GA ₃ Solution	346.4	77-06-5	0.29	0.9	1.4	2.02	2.6	2.9	N/A	Water	C	C	CA/F	0.01-5.0
G358	Gibberellins A ₁ +A ₇	N/A	N/A	N/A						EtOH	N/A	C	F	CA/F	0.01-5.0
I885	IAA	175.2	87-51-4	0.57	1.7	2.9	3.99	5.1	5.7	KOH	Water	F	F	CA/F	0.01-3.0
I364	IAA Solution, 1 mg/mL	175.2	87-51-4	0.57	1.7	2.9	3.99	5.1	5.7	N/A	Water	F	F	CA/F	0.01-3.0
I538	IBA	203.2	133-32-4	0.49	1.5	2.5	3.44	4.4	4.9	KOH	Water	C	F	CA/F	0.1-10.0
I460	IBA Solution, 1 mg/mL	203.2	133-32-4	0.49	1.5	2.5	3.44	4.4	4.9	N/A	Water	F	F	CA/F	0.1-10.0
I560	IBA K-Salt	241.3	60096-23-3	0.41	1.2	2.1	2.9	3.7	4.1	Water	Water	C	F	CA/F	0.1-10.0

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Prod. No	Growth Regulator	Mol. Wt.	CAS No.	mg/L to PGR μ M Conversion ¹ (See explanation below table)						Solvent ²	Dilute In	Store Prod.	Store Stock Soln.	Sterilize By	Typical Working Conc. (mg/L)
				0.1	0.3	0.5	0.7	0.9	1.0						
I409	IPA	189.2	830-96-6	0.52	1.6	2.6	3.69	4.8	5.3	KOH	Water	F	F	CA/F	0.1-10.0
P717	Picloram	241.5	2/1/1918	0.41	1.4	2.1	2.9	3.7	4.1	DMSO	N/A	RT	C	CA	0.01-10.0
J379	Jasmonic Acid	210.3	3572-66-5	0.47	1.4	2.4	3.32	4.3	4.8	EtOH	NA	C	F	F	0.01-100.0
J389	Methyl Jasmonate	224.3	39924-52-2	0.44	1.3	2.2	2.24	4	4.5	EtOH	NA	RT	F	F	0.01-100.0
K750	Kinetin	215.2	525-79-1	0.46	1.4	2.3	3.25	4.2	4.7	KOH	Water	F	F	CA/F	0.1-5.0
K438	Kinetin Solution, 1 mg/mL	215.2	525-79-1	0.46	1.4	2.3	3.25	4.2	4.7	N/A	Water	F	F	CA/F	0.1-5.0
M494	Maleic Acid Hydrazide	112.1	123-33-1	0.89	2.7	4.5	6.24	8	8.9	KOH	Water	RT	C	F	0.01-10.0
N600	NAA	186.2	86-87-3	0.54	1.6	2.7	3.76	4.8	5.4	KOH	Water	RT	C	CA	0.1-10.0
N605	NAA Solution, 1 mg/mL	186.2	86-87-3	0.54	1.6	2.7	3.76	4.8	5.4	N/A	Water	C	C	CA	0.1-10.0
N610	K-NAA	224.3	15165-79-4	0.44	1.3	2.2	3.12	4	4.5	Water	Water	RT	C	CA	0.1-10.0
N564	β -Naphthoxy-acetic Acid	202.2	120-23-0	0.49	1.5	2.5	3.48	4.5	5.0	KOH	Water	RT	C	CA	0.1-10.0
O630	Oryzalin	346.4	19044-88-3	0.29	0.9	1.4	2.02	2.6	2.9	DMSO	N/A	RT	C	CA	—
P687	Paclobutrazol	293.8	76738-62-0	0.34	1.0	1.7	2.4	3.1	3.4	DMSO	N/A	RT	C	CA/F	—
P694	Phloroglucinol	126.1	6009-90-7	0.79	2.4	4	5.55	7.1	7.9	Water	Water	RT	C	CA/F	up to 162
P717	Picloram	241.5	1918-02-1	0.41	1.2	2.1	2.90	3.7	4.1	DMSO	N/A	RT	C	CA/F	0.01-10.0
P733	Putrescine	161.1	333-93-7	0.62	1.9	3.1	4.35	5.6	6.2	Water	Water	RT	C	F	—
S837	Spermidine	145.3	124-20-9	0.69	2.1	3.4	4.82	6.2	6.9	Water	Water	C	C	F	—
S746	SADH	160.2	1596-84-5	0.62	1.9	3.1	4.37	5.6	6.2	Water	Water	C	C	CA/F	0.1-10.0
T818	Triacontanol	438.8	593-50-0	0.22	0.7	1.1	1.59	2.1	2.3	EtOH/DMSO	N/A	C	F	F	0.01-10.0
T888	Thidiazuron	220.2	51707-55-2	0.45	1.4	2.3	3.18	4.1	4.5	DMSO	N/A	RT	C	CA/F	0.001-0.05
T841	<i>meta</i> -Topolin	241.5	N/A	0.41	1.2	2.1	2.89	3.7	4.1	KOH	Water	RT	F	F	0.01-5.0
T828	Trifluralin	335.3	1582-09-8	0.30	0.8	1.5	2.09	2.7	3.0	DMSO	N/A	RT	C	F	—
T761	Trinexapac-Ethyl	252.3	95266-40-3	0.4	1.2	2.0	2.77	3.6	4.0	Water	Water	C	C	F	—
Z125	Zeatin	219.2	1637-39-4	0.45	1.4	2.3	3.19	4.1	4.6	KOH	Water	F	F	CA/F	0.01-5.0
Z860	Zeatin Solution, 1 mg/mL	219.2	13114-27-7	0.45	1.4	2.3	3.19	4.1	4.6	N/A	Water	F	F	CA/F	0.01-5.0
Z899	Zeatin Riboside	351.4	6025-53-2	0.28	0.9	1.4	1.99	2.6	2.9	KOH	Water	F	F	F	0.01-5.0
Z875	Zeatin Riboside Solution, 1 mg/mL	351.4	6025-53-2	0.28	0.9	1.4	1.99	2.6	2.9	N/A	Water	F	F	F	0.01-5.0

¹ mg/L to μ M conversion example: 0.1 mg/L of ABA = 0.38 μ M solution.

² Recommended concentration of KOH is 1 N.

Storage:

F = Freezer (-20 to 0 C)
 C = Cooler/ Refrigerator (2-6 C)
 RT = Room Temperature

Sterilize by:

CA = Co-autoclave with other media components
 F = Filter Sterilize (Heat labile or no heat stability information available)
 CA/F = Co-autoclave with media components, however, some loss of activity may occur

The above recommendations for storage and use are for informational purposes. End user assumes the responsibility for determining proper usage of the product.

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