

Product survey: Protein expression systems

New Protein Factories

Most researchers still stick to the traditional hosts *E. coli*, yeast, insect and mammalian cells for the expression of recombinant proteins. There are, however, many other interesting protein expression systems available.

In the early days of biochemistry, researchers studying functional or structural properties of proteins often had a hard time. The only way to capture their favourite protein was to isolate it from the original source and quite often it took months or even years to get a few milligrammes. Actually, back then, the major task was to isolate rather than to analyse the protein under investigation. The introduction of protein expression systems in the early 1980s has changed this picture completely and today expression of recombinant proteins for structural or functional analysis is routine in almost any life science lab.

If you ask researchers what expression system they use, most of them will answer *E. coli*. Maintaining *E. coli* cells is easy and cheap; they grow very fast and produce high amounts of recombinant protein; that's enough reason to make them the number one host for the expression of recombinant

proper folding of heterologously-expressed proteins. No wonder then, that a good deal of eukaryotic proteins accumulate in the *E. coli* cells cytoplasm forming insoluble protein aggregates, better known as inclusion bodies.

Tags against inclusion bodies

Protein expression experts may get the aggregated proteins back into solution with urea/guanidiniumhydrochloride and refold them in special buffers, however, it is much wiser to avoid inclusion bodies in advance. Researchers have developed several strategies to enhance the prospects of getting biological active proteins out of *E. coli* cells used as expression host. The most popular one, which increases both solubility and translational efficacy of the expressed protein, is the attachment of hydrophilic fusion tags at its N-terminus. You may choose tags out of an extended list; the most widely used are thioredoxin (trx), glutathione-S-transferase (GST), maltose binding protein (MBP) and NusA.

If all tricks fail to express a functional active protein in *E. coli*, however, it is time to change the expression system. As most researchers are not keen to work with cumbersome and hard to handle mammalian cells as expression host, they often use insect cells or yeasts as an initial alternative to *E. coli*. Insect cells used in common Baculovirus expression systems, such as *Spodop-*

tera frugiperda (Sf9, Sf21) and *Trichoplusia ni* (Tn5), are easy to cultivate and culturing is scalable from tiny millilitre volumes to large scale bioreactor quantities.

Though insect cells are able to post-translationally modify the expressed proteins similar to mammalian cells, they fail to add branched multi-antenna glycans to the expressed proteins, which may critical-

ly affect the properties of these proteins. Another drawback is the time-consuming generation of the necessary recombinant baculovirus, even though improved protocols such as the Bac-to-Bac method have cut back the time needed from several weeks to about three weeks.

The two most prominent yeasts used for heterologous protein expression are baker's yeast *Saccharomyces cerevisiae* and the methanol-utilising yeast *Pichia pastoris*, the latter becoming rather popular in recent years. The expression of foreign proteins in *Pichia pastoris* is regulated by the strong methanol-inducible AOX1 promoter, allowing the production of recombinant proteins at rather high levels. Similar to *Saccharomyces cerevisiae*, genetic manipulation of *Pichia pastoris* is fairly simple and has been exploited, e.g. to trim the N-glycosylation abilities of *Pichia pastoris* to get a mammalian-type glycosylation pattern.

Exotic expression systems

Though most researchers and companies rely on the classical expression hosts, *E. coli*, yeast, insect cells and mammalian cell lines such as Chinese hamster ovary (CHO), baby hamster kidney (BHK) and human embryonic kidney (HEK293) cells, there are a great many more interesting expression systems available. Actually, one may choose between dozens of more or less exotic expression systems and hosts respectively. Some of the better known are based on unconventional yeasts such as *Kluyveromyces lactis*, *Hansenula polymorpha* and *Zygosaccharomyces bailii*, or on numerous bacterial hosts like *Bacillus subtilis*, *Bacillus megaterium* and *Staphylococcus carnosus*. It is, however, also possible to express proteins in such exotic hosts as the shrimp *Penaeus styloirostris*, the duckweed algae *Lemna spp.* or in the endosperm of coconuts. Most of these expression systems are still relatively unknown; however, it is a fair guess, that some of them will sooner or later enter molecular biological laboratories to compete with *E. coli* and all the other traditional protein expression systems.

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Tastes delicious and may be used as protein expression system: coconut water.

proteins, especially prokaryotic ones. Since *E. coli* cells lack the ability to add typical posttranslational modifications to eukaryotic proteins, such as carbohydrates, methyl groups or phosphate, heterologous expression of certain eukaryotic proteins in *E. coli* may, however, be difficult or even impossible. To make things even more complicated, *E. coli* cells don't care much about the

Protein Expression Systems

Company	Name of product	Host	Short description	Miscellaneous, Specialities, Generally	Price [EUR]	
5 Prime Hamburg, Germany www.5PRIME.com Contact: J. Tesdorpf Phone: +49-40 3197927-0 info@5prime.com	RTS 100 <i>E.coli</i> HY Kit	Prokaryotic, cell free, <i>in vitro</i>	<i>E.coli</i> lysate for expression of up to 20 µg protein/reaction.	<ul style="list-style-type: none"> ■ Analytical scale ■ High yield ■ Linear and circular templates 	On request	
	RTS 500 Proteo-Master <i>E.coli</i> HY Kit	Prokaryotic, cell free, <i>in vitro</i>	<i>E.coli</i> lysate for expression of up to 6 mg protein/reaction.	<ul style="list-style-type: none"> ■ CECF (continuous exchange cell-free) ■ Medium scale ■ High yield ■ Circular templates 	On request	
	RTS 9000 <i>E.coli</i> HY Kit (10 ml)	Prokaryotic, cell free, <i>in vitro</i>	<i>E.coli</i> lysate for expression of up to 50 mg protein/reaction.	<ul style="list-style-type: none"> ■ CECF ■ High yield ■ Structural Studies ■ Large scale ■ Circular templates 	On request	
	RTS 100 <i>E.coli</i> disulfide kit	Prokaryotic, cell free, <i>in vitro</i>	<i>E.coli</i> CECF lysate for expression of up to 80 µg functional, properly folded, disulfide-bonded protein/reaction.	<ul style="list-style-type: none"> ■ CECF ■ High yield ■ Circular templates ■ Analytical scale ■ Disulfide-bonded proteins 	On request	
	RTS 500 <i>E.coli</i> disulfide kit	Prokaryotic, cell free, <i>in vitro</i>	<i>E.coli</i> CECF lysate for expression of up to 2.5 mg functional, properly folded, disulfide-bonded protein/reaction.	<ul style="list-style-type: none"> ■ CECF ■ High yield ■ Circular templates ■ Medium scale ■ Disulfide-bonded proteins 	On request	
	RTS 100 wheat germ CECF Kit	Eukaryotic, cell free, <i>in vitro</i>	Eukaryotic wheat germ CECF lysate for expression of up to 50 µg soluble eukaryotic protein/reaction.	<ul style="list-style-type: none"> ■ CECF ■ High yield ■ Linear & circular templates ■ Analytical scale ■ Eukaryotic proteins 	On request	
	RTS 500 wheat germ CECF Kit	Eukaryotic, cell free, <i>in vitro</i>	Preparative, eukaryotic wheat germ CECF lysate for expression of up to 1 mg soluble eukaryotic protein/reaction.	<ul style="list-style-type: none"> ■ CECF ■ High yield ■ Linear & circular templates ■ Medium scale ■ Eukaryotic proteins 	On request	
	RTS 100 <i>E.coli</i> LinTempGenSet, His-tag	Prokaryotic, cell free, <i>in vitro</i>	Expression of 6xHis-tagged proteins without cloning.	<ul style="list-style-type: none"> ■ 6xHis-tag ■ N- or C-terminal 	On request	
	RTS wheat germ LinTempGenSet, His6-tag	Eukaryotic, cell free, <i>in vitro</i>	Expression of 6xHis-tagged proteins without cloning.	<ul style="list-style-type: none"> ■ 6xHis-tag ■ N- or C-terminal 	On request	
Agilent Technologies Stratagene Division www.stratagene.com Contact: Stratagene_bioreagents@agilent.com	GeneJammer transfection reagent	Numerous cell lines	For transient or stable transfections in a wide variety of cell types.	<ul style="list-style-type: none"> ■ Transfection, adenovirus, DNA 	128.-	
	StrataClone mammalian expression vector system	Mammalian cells	Fast and easy topoisomerase-based blunt PCR cloning and expression with N- or C-linked functional tags.	<ul style="list-style-type: none"> ■ Topoisomerase, cloning, expression ■ Method completed in less than one day 	380.-	
	InterPlay mammalian TAP system	Mammalian cells	Based on expression of a protein of interest fused to two affinity tags	<ul style="list-style-type: none"> ■ Interacting, proteins, recovery, mammalian 	920.-	
	InterPlay adenoviral TAP system	Mammalian cells	Adenoviral delivery for increased protein yield in the broadest range of cell types	<ul style="list-style-type: none"> ■ Interacting, proteins, recovery, gene delivery 	1,352.-	
	AAV helper-free system	--	Viral-based gene delivery system	<ul style="list-style-type: none"> ■ Viral, gene delivery, adenovirus-free 	1,412.-	
	AdEasy adenoviral vector system	--	Utilizes homologous recombination in <i>E.coli</i> to rapidly construct viral particles containing your gene.	<ul style="list-style-type: none"> ■ Recombinant adenovirus, Infectivity ■ Up to 100% transduction efficiency, even on difficult-to-transfect cell lines 	924.-	
	Arctic express competent cells	<i>E.coli</i>	Enhanced protein folding and solubility of expressed proteins at low growth temperatures.	<ul style="list-style-type: none"> ■ Solubility, folding 	221.-	
	BL21-competent cells	<i>E.coli</i>	Provide high protein expression levels.	<ul style="list-style-type: none"> ■ Protein expression cells 	116.-	
	BL21-CodonPlus	<i>E.coli</i>	Dramatically improves expression when codon bias is a problem. For proteins from all organisms, not just mammals.	<ul style="list-style-type: none"> ■ Codon bias 	180.-	
BL21-Gold competent cells	<i>E.coli</i>	Accelerates the process of cloning a gene and expressing a recombinant protein.	<ul style="list-style-type: none"> ■ Cloning, protein expression 	144.-		
ATG:biosynthetics Merzhausen, Germany www.atg-biosynthetics.com Contact: Hubert Bernauer Phone: +49-761-8889424 order@atg-biosynthetics.com	ACEMBL-series of recombining expression vectors	--	Donor-acceptor based gene assembly cloning & expression vector system for combinatorial synthetic biology single and multivalent-serial multi-protein and parallel multi-protein-variant expression.	<ul style="list-style-type: none"> ■ Artificial biochemical pathway assembly ■ Functional protein complex assembly ■ Gene libraries ■ Combination of gene libraries for functional screenings and selection 	--	
	ColiFlex	<i>E.coli</i>	--	--	950.-	
	BacuFlex	Insect cells	--	--	--	2,450.-
	MamaFlex	Mammalian	--	--	--	2,900.-

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BioCat Heidelberg, Germany www.biocat.com Contact: Elke Gamer Phone: +49-6221-7141516 gamer@biocat.com	cDNA and ORF clones	Depending on expression vector	Gene-specific cDNA and ORF clones from various organisms (<i>Homo sapiens</i> , <i>Mus musculus</i> , <i>Rattus norvegicus</i> , <i>Bos taurus</i> , etc.) and collections, e.g. IMAGE/MGC	<ul style="list-style-type: none"> ■ Full-length cDNA clones in cloning or expression vectors, e.g. pCMV-SPORT6 ■ ORF clones in Gateway entry vectors ■ Standard / sequence-verified cDNA clones / ORF clones 	75.-/125.- (cDNA) 125.-/175.- (ORF)
	Competent cells for protein expression	<i>E. coli</i>	<i>E. coli</i> Express BL21 (DE3) cells for routine protein expression	<ul style="list-style-type: none"> ■ High efficiency chemically competent or electrocompet. cells ■ Routine expression (T7 prom.) ■ T7 lysozyme-expressing strains to repress low-level expression prior to induction available 	Depending on pack size
	Competent cells for protein expression	<i>E. coli</i>	<i>E. coli</i> 10GF cells for routine protein expression	<ul style="list-style-type: none"> ■ High efficiency chemically competent or electrocompetent cells ■ Routine expression (Tac promoter) 	Depending on pack size
	Comp. cells for expression of toxic & membrane proteins	<i>E. coli</i>	OverExpress C41 (DE3) and OverExpress C43 (DE3) cells for the expression of toxic proteins and membrane proteins	<ul style="list-style-type: none"> ■ High efficiency chemically or electrocompetent cells 	Depending on pack size
	Competent cells for expression of very toxic proteins	<i>E. coli</i>	OverExpress C41 (DE3) pLysS and OverExpress C43 (DE3) pLysS cells for the expression of very toxic proteins	<ul style="list-style-type: none"> ■ High efficiency chemically or electrocompetent cells ■ ComboPack containing 4 strains: C41(DE3), C41(DE3) pLysS, C43(DE3), C43(DE3) pLysS available 	Depending on pack size
	F. Phage display, expression, & cloning	<i>E. coli</i>	ER2738, TG1, and SS320 (MC1061 F ⁻) cells optimized for phage display	<ul style="list-style-type: none"> ■ Electrocompetent cells ■ Efficiency > 2x 10¹⁰ 	Depending on pack size
	Expresso competent mammalian cells	Mammalian cells	Specially prepared HeLa, CHO-K1, HEK 293, COS-7, NIH-3T3 cells for up to 5x higher protein yields	<ul style="list-style-type: none"> ■ Pre-counted, pre-aliquoted versions of their standard counterpart cell lines ■ Ready-to-use ■ Thaw cells, plate and transfect them 3 hours later ■ High transfection efficiency ■ 4x higher cell density, up to 5x higher protein yields 	229.- (1 vial, 10 million cells) 299.- (2 vial, 2 x 10 mill.)
	Recombinant adenoviruses	Mammalian cells	Ready-to-use adenoviral particles expressing recomb. proteins involved in cell cycle control, cell signaling, and cytoskeletal regulation.	<ul style="list-style-type: none"> ■ Transient expression of high protein amounts in dividing and non-dividing cells ■ Virus remains epichromosomal ■ Cells exhibiting low transfection efficiency 	625.- (50 µl, 1x 10 ¹¹ VP/ml)
	Recombinant retroviral vectors	Mammalian cells	Retroviral vectors expressing recombinant proteins	<ul style="list-style-type: none"> ■ Efficient gene delivery using retroviral particles ■ Stable expression of proteins in dividing cells 	499.-
	Platinum retroviral expression systems	Mammalian cells	Retroviral expression systems for ES (embryonal stem), EC (embryonal carcinoma) or HS (hematopoietic stem) Cells	<ul style="list-style-type: none"> ■ Incl. expression and control vectors, and packaging cell line ■ Platinum-A (amphotropic), -E (ecotropic), & -GP (pantropic) packaging cell lines also available separately 	895.-
Lentiviral expression systems	Mammalian cells	HIV- & FIV-based lentiviral expression vectors/kits for protein expression in a wide range of dividing and quiescent mammalian cells	<ul style="list-style-type: none"> ■ Expression driven by CMV, EF1, or MSCV promoter ■ Promoterless vectors also available ■ Provided with or without packaging plasmids/cell line 	Depending on contents and size	
BioConcept Allschwil, Switzerland www.bioconcept.ch Contact: R. Liebetanz Phone: +4161-4868080 info@bioconcept.ch	SF-4 Baculo express insect cell culture medium	SF9, SF21	Ready-to-use insect cell culture medium for Baculovirus expression	<ul style="list-style-type: none"> ■ Size: 500 ml, special sizes/packaging on request 	29.-
	MAM-PF media	CHO	Chemically def. cell culture media f. production of recombinant proteins with CHO cells	<ul style="list-style-type: none"> ■ Custom made media on request 	Various
Biomol Hamburg, Germany www.biomol.de Contact: Edgar Lipsius Phone: +49-40-853260-37 e_lipsius@biomol.de	APX system - adjustable protein expression vectors	Mammalian cells	Genetic fusion to a destabilization domain (DD) confers instability to the protein of interest, resulting in proteasomal degradation.	<ul style="list-style-type: none"> ■ Available as cloning vectors for a protein of interest ■ Also available as ready-to-use plasmids or lentiviral particles for the generation of inducible pluripotent stem cells (iPSCs) ■ For constitutive expression vectors with DYKDDDDK-fusions are offered ■ Sequenced and validated ORFs 	755.- (APX plasmids, 1 tube) 659.- (APX lentivirus, 1 tube)
Bio-Rad Laboratories Munich, Germany www.bio-rad.com Contact: Timothy Cross Phone: +49-89-31 884-0 Tim_cross@bio-rad.com	Profinity eXact fusion-tag system	BL21 (DE3) <i>E. coli</i> cells	This <i>E. coli</i> based expression and purification system generates a tag-free, highly purified protein containing its native N-terminal amino acid sequence in a single step, without the addition of protease.	<ul style="list-style-type: none"> ■ Single-step tag-free system 	103.- to 689.-
IBA Goettingen, Germany www.stargate-cloning.com Contact: Isabel Schuchardt Phone: +49-551 50672-0 info@iba-go.com	StarGate newcomer set	<i>E. coli</i> , yeast, mammalian, insect cells	An easy-to-handle subcloning system to screen for the optimal expression conditions for a certain gene of interest.	<ul style="list-style-type: none"> ■ 50% discount compared to individual sets ■ Set provides all products required ■ Large number of acceptor vectors with diff. features available 	272.50
	StarGate fusion cloning sets	F. IRES1/SD1: <i>E. coli</i> & mam. For LINK1: <i>E. coli</i> , mammalian, yeast & insect cells	Two or more genes can be brought into operative linkage by an intergenic region (IRES, SD, LINK1). Note: StarGate newcomer set (see above) and acceptor vectors (see below) are required in addition	<ul style="list-style-type: none"> ■ IRES1: Internal ribosomal entry site (IRES) for polycistronic gene expression in mammalian cells from 1 expression vector ■ SD1: Shine-Dalgarno (SD) sequences for the construction of artificial operons in <i>E. coli</i> ■ LINK1: Amino acid linker (GSGGGGGGS) for the generation of fusion proteins 	430.- each
	StarGate mutagenesis entry cloning set	<i>E. coli</i> , yeast, mammalian, insect cells	Tool for site-specific modification of the gene of interest.	<ul style="list-style-type: none"> ■ Easy-to-use "StarPrimer D'Signer" software to design the required primers is coming with the set ■ StarGate transfer reagent set, competent cells and acceptor vectors (see below) are required in addition 	245.-

Protein Expression Systems

Company	Name of product	Host	Short description	Miscellaneous, Specialities, Generally	Price [EUR]
IBA (continued from page 60)	StarGate acceptor vectors	<i>E.coli</i> , yeast, mammalian, insect cells	Provides different promoters, tags and signal sequences for the efficient expression of your protein of interest.	<ul style="list-style-type: none"> ■ Purification tags presently available: Strep-tag II, One-StREP-tag, 6xHistidine-tag, FLAG-tag, GST-tag with PreScission (PSC) site 	80.- (Up to 50% discount)
Invitrogen Paisley, United Kingdom www.invitrogen.com Contact: Lora.Daisley@invitrogen.com	pcDNA3.3-TOPO TA mammalian expression	Mammalian expression	Expression of exceptionally high levels of recombinant protein in adherent- or suspension-adapted mammalian cells	<ul style="list-style-type: none"> ■ Obtain up to five-fold higher protein yields ■ Fast, simple, high efficient TOPO cloning saves time ■ Express native proteins ■ Complete kit contains all necessary cloning reagents 	See website
	ViraPower HiPer-form expression kits	Mammalian expression	Lentiviral systems are ideal for stable gene expression.	<ul style="list-style-type: none"> ■ Stable expression ■ Long-term experiments ■ Accurate titer of functional virus ■ Gateway recombination & TOPO cloning technology available 	See website
	Jump-In targeted integration kits	Mammalian expression	Uses PhiC31 integrase-mediated recombination to stably integrate your choice of DNA sequence at specific genomic locations called pseudo-attP sites in mammalian cells.	<ul style="list-style-type: none"> ■ Long term stable expression: up to 13 passages ■ Integration into specific transcriptionally active hot spots ■ One step targeted integration procedure ■ Flexibility to integrate greater than 6 kb DNA fragments ■ Convenience of MultiSite gateway kits 	See website
	The FreeStyle MAX system	Mammalian expression CHO and 293 cells	Rapid, high-yield protein production using mammalian cells.	<ul style="list-style-type: none"> ■ Easy, rapid protocol ■ Functional proteins in 1 week ■ Simplified downstream purification of secreted proteins in serum-free medium ■ Straightforward protocol for production scale-up 	See website
	Bac-to-Bac baculovirus expression system	Insect expression	Delivers a robust and proven method to produce recombinant baculovirus, expressing your gene of interest in insect cells.	<ul style="list-style-type: none"> ■ High yields of recombinant protein in insect cells ■ Simple quick 5 minute blunt TOPO cloning saves time ■ N- and C-Terminal 6xHis tag for easy purification ■ TEV protease sites offer ability to remove both N- and C-Terminal tag for a native protein 	See website
	--	Bacterial expression	Expression is induced from the strong T7lac promoter. The BL21 Star <i>E.coli</i> expression strain, included with the system, improves mRNA stability, further increasing protein yields.	<ul style="list-style-type: none"> ■ Protein of interest can reach levels greater than 50 percent of total cellular protein ■ Improved stability of mRNA transcripts increases protein expression up to ten-fold ■ Simplified, efficient directional TOPO cloning ■ 7 Champion pET directional TOPO expression vectors 	See website
	PichiaPink yeast expression system	Yeast expression	Yeast expression system enable high yields of recombinant protein to be produced efficiently and cost effectively.	<ul style="list-style-type: none"> ■ Deliver up to grams per liter of expressed recombinant protein ■ Flexibility for inducible, constitutive, intracellular, or secreted expression ■ Produce mammalian-like proteins ■ Cost efficient method for large scale production 	See website
	MembraneMax protein expression kits	Cell-free expression	Allowing you to produce high yields of soluble (dispersed) membrane proteins using the MembraneMax reagent.	<ul style="list-style-type: none"> ■ High yield ■ Simple purification with His tag ■ Soluble membrane protein-NLP complexes ■ Simply add your gene of interest to get started 	See website
	OptiCHO protein expression kit	CHO expression	Serum-free stable cell line single-subunit or two-subunit protein expression.	<ul style="list-style-type: none"> ■ Products are designed to work together synergistically 	See website
Expression competent cells BL21 cells & strains	Expression competent cells	Chemically competent BL21(DE3) <i>E.coli</i> for use with bacteriophage T7 promoter-based expression systems.	<ul style="list-style-type: none"> ■ Optimized transformation ■ High level of protein production 	See website	
Jena Bioscience Jena, Germany www.jenabioscience.com Contact: Reinhard Breitling Phone: +49-3641-6285125 Reinhard.Breitling@jenabioscience.com	<i>Leishmania tarentolae</i> protein expression kit „LEXSY“	<i>Protozoan Leishmania tarentolae</i>	Cost-efficient robust unicellular system enabling eukaryotic post translational protein modifications.	<ul style="list-style-type: none"> ■ Constitutive inducible intracellular secretory expression 	From 960.-
Takara Bio Europe Saint-Germain-en-Laye, France www.takara-bio.eu Contact: Lonza Verviers (Distributor) Phone: +32 87 321 611 Info.europe@lonza.com	Brevibacillus expression system	<i>Brevibacillus choshinensis</i>	The gram positive bacterium <i>Brevibacillus choshinensis</i> has excellent ability to produce many kinds of proteins extracellularly.	<ul style="list-style-type: none"> ■ Proteins are very efficiently secreted and are active ■ Products remain unscathed in the culture medium ■ Guaranteed to be safe and amenable to genetic engineering 	1,500.-
	pCold vector set	All strains of <i>E.coli</i>	Based on cold-shock protein A (cspA) promoter and UTRs the pCold vectors family allows over expression of proteins at low temperature (i.e. 15°C).	<ul style="list-style-type: none"> ■ Yield can reach up to 60% of expressed intracellular protein ■ Higher level of soluble expression, improved stability ■ Wide range of <i>E.coli</i> hosts ■ Compatible with chaperone plasmids vectors ■ Up to 90% of newly expressed cellular protein is target protein 	1,183.30 411.50 (each)
	pCold TF DNA	All strains of <i>E.coli</i>	Expression of the target protein fused with trigger factor, a chaperone protein, for better refolding.	<ul style="list-style-type: none"> ■ Cutting site of 3 proteases to release the N-terminal tag ■ pCold TF vector contains cspA promoter and thus have the same features as pCold vectors (see above) 	969.-
	SPP system (single protein production system)	All strains of <i>E.coli</i>	The co-expression of the mRNA interferase mazF with the target protein leads to the production of this protein only, since all other mRNA are degraded.	<ul style="list-style-type: none"> ■ Ideal for labelling of the proteins, since it is the only one newly produced ■ SPP vectors contain cspA promoter and thus have the same features as pCold vectors (see above) 	1,732.30 969.- (each)

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Merck Chemicals Calbiochem, Novaiocem, Novagen Nottingham, United Kingdom www.merckbio.eu Contact: Phone: +44 115 9430 840 Customer.service@merckbio.eu	pET vector system	<i>E.coli</i>	Well-established system offering a wide range of vectors and expression strains, resulting in tight control and high expression levels.	<ul style="list-style-type: none"> ■ Choice of different restriction sites, purification, solubility tags ■ Coexpression of several proteins possible ■ Expression strains available as competent cells ■ Specialized expression strains for eukaryotic proteins and proteins rich in disulfide bonds 	See website
	Insect cell expression	<i>Spodoptera frugiperda</i> (Sf9)	Plasmid-based and baculovirus-mediated expression (transient or stable) of proteins in Sf9 cells.	<ul style="list-style-type: none"> ■ Plasmid-based InsectDirect expression ■ High levels of heterologous protein expression ■ Accelerated recombinant baculovirus generation ■ Dual-purpose vectors 	See website
	pBiEx / pTriEx	<i>E.coli</i> , insect cells and mammalian cells	Multisystem expression system for easier transfer between species	<ul style="list-style-type: none"> ■ pBiEx for nonlytic expression in insect cells plus tightly regulated <i>E.coli</i> expression ■ pTriEx: one construct for efficient expression in bacterial, insect and mammalian systems 	See website
	Ligation independent cloning	<i>E.coli</i>	Ligation independent cloning (LIC) system for rapid, efficient directional cloning.	<ul style="list-style-type: none"> ■ No restriction digestion or ligation ■ Greater than 95% recombinants ■ Clone directly into a wide variety of expression vectors 	See website
	Gateway expression system	<i>E.coli</i>	Universal platform to shuttle target genes into a wide variety of expression and functional analysis systems.	<ul style="list-style-type: none"> ■ Combines pET system advantages with effic. Gateway cloning ■ Efficiently transfers target genes between different vectors ■ Wide choice of N-an C-terminal fusion tags ■ Vectors available separately or in expression systems 	See website
MoBiTec Goettingen, Germany www.mobitec.com Contact: Phone: +49-551 70722 75 info@mobitec.com	<i>Bacillus megaterium</i> expression system	<i>Bacillus megaterium</i>	The system has no alkaline proteases activity at all and is tightly regulated.	<ul style="list-style-type: none"> ■ Stable, high-yield protein expression ■ Versatile production, versatile purification ■ Removeable tag versions 	On request
	<i>Bacillus subtilis</i> expression vectors	<i>Bacillus subtilis</i>	Non-pathogenic and considered as a GRAS organism.	<ul style="list-style-type: none"> ■ Purification with different tags is possible ■ Also as cold-inducible vector available 	On request
	NICE expression system for <i>Lactococcus lactis</i>	<i>Lactococcus lactis</i>	Fully food grade system that has no problems with inclusion bodies or spores.	<ul style="list-style-type: none"> ■ No endotoxins and no extracellular proteinases ■ Tightly controlled expression ■ Simple fermentation, scale-up & down stream processing 	On request
Progen Biotechnik Heidelberg, Germany www.progen.de Contact: Gerda Bruder Phone: +49-6221 827815 info@progen.de	Baculo expression vector pAc-κ	Production in insect cells	Expression of human IgG heavy and light chains in insect cells and secretion of assembled IgG (κ) antibodies.	<ul style="list-style-type: none"> ■ Suitable for cloning of heavy and light chain Fv antibody gene fragments 	260.-
	Baculo expression vector pAc-κ-Fc	Production in insect cells	Expression of human IgG (κ) in insect cells and secretion of assembled antibodies into the supernatant.	<ul style="list-style-type: none"> ■ Suitable for cloning of heavy and light chain Fab antibody gene fragments 	260.-
	Baculo expression vector pAc-λ	Production in insect cells	Expression of human IgG heavy and light chains (λ) in insect cells and secretion into the supernatant.	<ul style="list-style-type: none"> ■ Suitable for cloning of heavy and light chain scFv antibody gene fragments 	260.-
	Baculo expression vector pAc-λ-Fc	Production in insect cells	Expression of human IgG (λ) in insect cells and secretion into the supernatant.	<ul style="list-style-type: none"> ■ Suitable for cloning of heavy and light chain Fab antibody gene fragments 	260.-
	POPE 101 expression vector	<i>E.coli</i>	Expression of functional recombinant single-chain Fv antibodies.	<ul style="list-style-type: none"> ■ Suitable for heavy and light chain variable domain genes of Fv antibody fragments 	260.-
	PSEX81 Surface expression phagemid vector	<i>E.coli</i>	Expression of functional recombinant single-chain Fv antibody pIII fusion proteins on surface of M13 filamentous phage.	<ul style="list-style-type: none"> ■ Suitable for expression on M13 in <i>E.coli</i> 	260.-
	Hyperphage PRH YPEPRHYPE-XS	<i>E.coli</i>	Provides helper phage function in packaging a common phage display phagemid.	<ul style="list-style-type: none"> ■ Infection of bacteria via pIII 	475.- / 100.- (5/1 x 2 ml)
Promega Mannheim, Germany www.promega.com/de Contact: Truc N. Bui Phone: +49-621 8501-0 truc.bui@promega.com	S30 T7 high-yield protein expression system	Cell free <i>E.coli</i> S30 system,	Designed to express up to 500 µg/ml of protein in 1 hour from plasmid vectors containing a T7 promoter.	<ul style="list-style-type: none"> ■ Detect expressed proteins by Coomassie staining or incorporation of fluorescent or biotinylated tRNA ■ Reagents all inclusive with the kit ■ Protein:protein interactions, protein:DNA interactions, antibody production 	149.- (8 reactions)
	TNT T7 insect cell extract protein expression system	Cell free system based on <i>frugiperda</i>	Coupled transcription and translation reaction one step single tube design. Simply add DNA template and incubated at 28-30°C, reaction completed within 4 hours.	<ul style="list-style-type: none"> ■ Completed within 4 h ■ Express up to 75 µg/ml posttranslational modified and functional proteins ■ Reagents all inclusive with the kit ■ Companion vectors designed to achieve optimal yield 	180.- (reactions)
	TNT SP6 high-yield wheat germ protein expression system	Cell free system based on wheat germ extract	Coupled transcription and translation reaction one step single tube design. Express posttranslational proteins with yield range of 10-100 µg/ml within only 2 hours.	<ul style="list-style-type: none"> ■ Express functional proteins within 2 h ■ Reagents all inclusive with the kit ■ Optional protein labeling reagents available 	194.- (300 µl)
	Cell free protein expression: TNT quick coupled transcription/translation system	Cell free system based on rabbit reticulocyte lysate	Single-tube, coupled transcription/translation reactions for eukaryotic cell-free protein expression.	<ul style="list-style-type: none"> ■ Just add circular plasmid DNA containing a T7 or SP6 promoter or a PCR-generated fragment containing a T7 promoter to the reaction mix ■ Express functional proteins in just 60-90 minutes ■ Expression of genes driven by T7 / SP6 RNA polym. promoters 	149.- (5 reactions)

Protein Expression Systems

Company	Name of product	Host	Short description	Miscellaneous, Specialities, Generally	Price [EUR]
PromoCell Heidelberg, Germany www.promokine.info Contact: Technical Support Phone: +49-6221 64934-0 info@promokine.info	pPK-CMV expression vectors	Mammalian cells	Vectors contain a modified human cytomegalovirus (CMV) based promoter/enhancer sequence optimized for constitutive high-level gene expression in mammalian cells.	<ul style="list-style-type: none"> ■ Suitable for both stable and transient expression ■ Small size for increased transfection efficiency ■ Convenient multiple cloning site ■ Positive control vector containing a CAT gene 	259.- (25 µg)
	pPK-CMV fusion vectors	Mammalian cells	Vectors contain an optimized CMV promoter and an intron sequence which ensures extremely high constitutive expression of GFP or Luciferase fusion proteins in a wide variety of mammalian cell types. They also enable creating GFP or Luciferase expressing stable cell lines.	<ul style="list-style-type: none"> ■ Convenient choice of GFP / Luciferase reporter genes ■ Two multiple cloning sites ■ Kanamycin/Neomycin resistance gene provide efficient vector selection in <i>E.coli</i> or mammalian cells ■ SV40 polyadenylation sign provides for stable mRNA ■ pUC Origin of replication provides high copy number of vector in <i>E.coli</i> 	329.- (20 µg)
	FastClone PCR cloning kits	Mammalian cells	Kits for rapid and directional cloning of PCR fragments into the powerful pPK-CMV vectors for gene expression in mammalian cells.	<ul style="list-style-type: none"> ■ Fast, convenient and directional PCR cloning ■ No need for restriction or ligation enzymes ■ Cloning efficiency is greater than 85% ■ Powerful pPK-CMV vectors for high-level gene expression in mammalian cells ■ Available for native or HA-tagged protein expression 	295.- (20 reactions)
	FastExpress gene expression kits	Mammalian cells	Adds a strong eukaryotic promoter and terminator sequence to any target gene of interest via a simple 2-step PCR procedure.	<ul style="list-style-type: none"> ■ Excellent gene expression <i>in vitro</i> and <i>in vivo</i> ■ Easy and adaptable for all genes ■ High-throughput screening of functional gene expression ■ Rapid screening of genes for intracellular localization studies 	229.-/625.- (20/100 reactions)
	StarGate cloning systems	Mammalian cells, <i>E.coli</i> , yeast cells, insect cells	Combinatorial cloning enables optimal expression of your protein of interest with various features in different hosts.	<ul style="list-style-type: none"> ■ One-tube, easy-to-handle subcloning of your gene of interest into diverse high-level expression vectors ■ Minimal modification of the gene of interest ■ Improved, systematic screening of different elements and host/tag combinations ■ Inherent highest level cloning efficiency 	195.- (entry cloning set); 249.- (transfer reagent set) 79.- (each accep. vect.)
Sigma-Aldrich Chemie Taufkirchen, Germany www.sigmaaldrich.com Contact: Phone: 0180 2237135 Eurtchserv@sial.com Phone: +49-89-6513-0 deorders@sial.com	FLS <i>E.coli</i> FLAG-shift expression kit	<i>E.coli</i>	Vectors provide a choice of secreted or cytoplasmic expression of N-terminal FLAG fusion proteins, respectively, under control of the tac promoter.	<ul style="list-style-type: none"> ■ Detect 10 femtomoles; 20-200× more sensitive than any other system ■ Enhanced detection for immunoprecipitation, Western blots and immunocytochemistry ■ Single band purity with only one purification step using ANTI-FLAG antibodies and affinity gels ■ ANTI-FLAG antibodies exhibit little or no cross-reactivity in mammalian and bacterial cell lysates 	677.-
	FLA <i>E.coli</i> amino-terminal FLAG expression kit	<i>E.coli</i>	Expression Vectors provide a choice of secreted or cytoplasmic expression of N-terminal FLAG fusion proteins, respectively, under control of the tac promoter.	<ul style="list-style-type: none"> ■ Detect 10 femtomoles; 20-200× more sensitive than any other system ■ Enhanced detection for immunoprecipitation, Western blots and immunocytochemistry ■ Single band purity with only one purification step using ANTI-FLAG antibodies and affinity gels ■ ANTI-FLAG antibodies exhibit little or no cross-reactivity in mammalian and bacterial cell lysates 	695.-
	FLMAS mammalian amino-terminal FLAG stable expression	Mammalian cells	Transient or stable expression of secreted or cytoplasmically expressed fusion proteins.	<ul style="list-style-type: none"> ■ Highly sensitive; detect 100 femtomoles ■ Detect 10 femtomoles; 20-200× more sensitive than any other system ■ Enhanced detection for immunoprecipitation, Western blots and immunocytochemistry ■ Single band purity with only one purification step using ANTI-FLAG antibodies and affinity gels ■ ANTI-FLAG antibodies exhibit little or no cross-reactivity in mammalian and bacterial cell lysates 	993.-
	FLMC mammalian carboxy-terminal FLAG transient expression Kit	Mammalian cells	The pFLAG-CMV-5a,b,c Expression Vectors (E3762) make all reading frames of the MCS available at each restriction site for cloning of an open reading frame.	<ul style="list-style-type: none"> ■ Detect 10 femtomoles; 20-200× more sensitive than other systems ■ Enhanced detection for immunoprecipitation, Western blots and immunocytochemistry ■ Single band purity with only one purification step ■ ANTI-FLAG antibodies exhibit little or no cross-reactivity in mammalian and bacterial cell lysates 	762.-
Clontech www.clontech.com Contact: Takara Bio Europe / Clontech Klaus Hentrich, Phone (toll free): 0800234 8063 (UK) 0800 1825178 (Germany) tech@clontech-europe.com	Bacterial expression and purification starter kits	<i>E.coli</i>	Complete kits for His-tagged protein expression and purification in <i>E.coli</i> .	<ul style="list-style-type: none"> ■ pET-based vectors for tight expression control/high inducibility ■ Vectors for both N- or C-terminal polyhistidine-tagging incl. ■ Broad choice of His-affinity purification formats ■ Optimize procedure for highest purity/binding capacity 	Please inquire
	BacPAK baculovirus expression system	Insect cells	Fast and efficient construction of recombinant baculovirus through cotransfection with shuttle vector, and recombination in insect host cells.	<ul style="list-style-type: none"> ■ Simple, efficient cloning procedure ■ High yield of recombinant protein ■ Shuttle vectors for polyhistidine tagging/IMAC purification available ■ Complete line of Baculovirus expression products available 	Please inquire
	Tet-On and Tet-Off advanced inducible gene expression systems	Mammalian cells	Doxycycline-inducible protein expression through a unique Dox-responsive transcription factor/promoter pair.	<ul style="list-style-type: none"> ■ The most popular inducible expression system ■ Tight expression control and high inducibility ■ Permits dose-dependent regulation of expression ■ Higher maximal protein expression levels than with CMV promoter 	Please inquire
Sven Gensler 0800234 8063 (UK) 0800 1825178 (Germany) tech@clontech-europe.com					