

Biotechnology

A Laboratory Skills Course



*Biotechnology: A Laboratory Skills Course,
Second Edition*

Planning and Purchasing Guide

This pacing guide suggests curricula for introductory or advanced biotechnology courses using activities in *Biotechnology: A Laboratory Skills Course, Second Edition*. Visit bio-rad.com/textbook for more information about the textbook.

Pacing Guides

The guide is paced for both a high school course (118 periods) and a college course (17 weeks with two 3–4 hr lessons per week). While we recommend including PCR in any biotechnology course, Table 2 provides a pacing guide that does not include PCR for

those conducting a biotechnology course with minimal equipment. More activities are included in the textbook than can fit into a year-long course, so each guide uses a different selection of activities. Also note that these are rough estimates and each teaching situation is different.

Table 1. Pacing guide for an introductory and advanced course at high school or college.

Time Frame		Background Lectures and Discussions	Introductory Course	Advanced Course
High School	College			
4 periods or 2 block periods	Week 1	Orientation What is biotechnology? Survey of the industry Lab safety Lab equipment Lab notebooks	Activity 2.A DNA Extraction and Precipitation Activity 2.B Pipetting	
10 periods or 4 block periods	Weeks 2–3	Basic skills and math Significant figures Scientific notation Solution making (molar, compound molar, and dilutions)	Activity 2.C Kool-Aid Column Chromatography Activity 2.D Making Solutions	
15 periods or 6 block periods	Weeks 4–5	Basic microbiology techniques and background Aseptic technique	Activity 3.A Making Microbiology Media Activity 3.C Microbes and Health Activity 3.D Gram Staining Activity 3.E Quantifying Bacterial Numbers	
15 periods or 6 block periods	Weeks 5–6	Restriction enzymes and their uses Applications of recombinant technology	Activity 4.A Restriction Site Prediction Using NEBcutter Activity 4.B Casting Agarose Gels Activity 4.C Dye Electrophoresis Activity 4.D Restriction Digestion and Analysis of Lambda DNA	Activity 4.A Restriction Site Prediction Using NEBcutter Activity 4.B Casting Agarose Gels Activity 4.D Restriction Digestion and Analysis of Lambda DNA
12 periods or 5 block periods	Weeks 7–8	Forensic science RFLP testing Links to crime Other applications of fingerprinting Plasmids and their uses	Activity 4.E Forensic DNA Fingerprinting Activity 4.F Plasmid Mapping Activity 5.B Bacterial Transformation with pGLO	Activity 5.A Bacterial Transformation with S3 Plasmid Activity 5.B Bacterial Transformation with pGLO Activity 5.C Purification of S3 and pGLO Plasmids Activity 5.D DNA Quantitation
10 periods or 4 block periods	Weeks 9–10	History of PCR PCR and DNA replication Use of PCR in agriculture Use of PCR in human migration Applications of PCR	Activity 6.A STR PCR Analysis Activity 6.B GMO Detection by PCR	Activity 6.B GMO Detection by PCR* Activity 6.C Detection of the Human PV92 Alu Insertion* Activity 6.D Fish DNA Barcoding*
12 periods or 5 block periods	Weeks 11–12	Protein background and structure Protein quantitation Protein separation PAGE Enzymes and biofuels Protein bioinformatics	Activity 7.A Protein Quantitation Using the Bradford Assay Activity 7.B Size Exclusion Chromatography Activity 7.E Biofuel Enzyme Activity Activity 7.F Exploring Bioinformatics with GFP	Activity 7.C GFP Purification by HIC Activity 7.D SDS-PAGE of Fish Muscle Activity 7.E Biofuel Enzyme Activity Activity 7.F Exploring Bioinformatics with GFP
10 periods or 5 block periods	Weeks 13–14	Immunity and response to infection Antibodies and their uses	Activity 8.A Ouchterlony Double Immunodiffusion Assay Activity 8.B Serum Antibody Detection by ELISA	Activity 8.C Quantitative ELISA Activity 8.D Western Blotting
30 periods 12 block periods	Weeks 15–17	Project		

* Choose which PCR lab best fits the learning goals of your class.

Table 2. Pacing guide for an introductory course with minimal equipment* at high school or college.

Time Frame		Background Lectures and Discussions	Course with Minimal Equipment
High School	College		
4 periods or 2 block periods	Week 1	Orientation What is biotechnology? Survey of the industry Lab safety Lab equipment Lab notebooks	Activity 2.A DNA Extraction and Precipitation Activity 2.B Pipetting (partial)
15 periods or 6 block periods	Weeks 2–4	Basic skills and math Significant figures Scientific notation Solution making (molar, compound molar, and dilutions)	Activity 2.C Kool-Aid Column Chromatography Activity 2.D Making Solutions Activity 2.E Titration
15 periods or 6 block periods	Weeks 5–6	Basic microbiology techniques and background Aseptic technique Eukaryotic cells	Activity 3.A Making Microbiology Media Activity 3.B Disk Diffusion Test Activity 3.C Microbes and Health Activity 3.D Gram Staining Activity 3.E Quantifying Bacterial Numbers Activity 3.F Staining Eukaryotic Cells
15 periods or 6 block periods	Weeks 7–8	Restriction enzymes and their uses Applications of recombinant technology	Activity 4.A Restriction Site Prediction Using NEBcutter Activity 4.B Casting Agarose Gels Activity 4.C Dye Electrophoresis Activity 4.D Restriction Digestion and Analysis of Lambda DNA
12 periods or 5 block periods	Weeks 9–10	Forensic science RFLP testing Links to crime Other applications of fingerprinting PCR background Plasmids and their uses	Activity 4.E Forensic DNA Fingerprinting Activity 4.F Plasmid Mapping Activity 5.B Bacterial Transformation with pGLO
12 periods or 5 block periods	Weeks 11–12	Protein background and structure Protein quantification Protein separation PAGE Enzymes and biofuels Protein bioinformatics	Activity 7.A Protein Quantitation Using the Bradford Assay Activity 7.B Size Exclusion Chromatography Activity 7.E Biofuel Enzyme Activity Activity 7.F Exploring Bioinformatics with GFP
10 periods or 5 block periods	Weeks 13–14	Immunity and response to infection Antibodies and their uses	Activity 8.A Ouchterlony Double Immunodiffusion Assay Activity 8.B Serum Antibody Detection by ELISA
30 periods or 12 block periods	Weeks 15–17	Project	

Purchasing Guide

Whether you are adding to existing equipment or starting with nothing, the following guide should provide relevant information for setting up and supporting a biotechnology course.

Basic Laboratory Essentials

Every biotechnology laboratory should have the basic laboratory equipment listed in Table 3. Common equipment used in more than two activities is listed here. The quantities required depend on your needs and what is already available. Many of the items are cross-functional and may be available from other classrooms within the science department.

Biotechnology Equipment and Materials

The need for specialized biotechnology equipment will depend on whether you follow the activities recommended in the introductory or advanced courses described in the pacing guides or follow individual activities when designing your own course.

Equipment, kits, and other supplies necessary to conduct the activities are listed in the following tables with ordering information for the three courses outlined in the pacing guide.

Introductory Biotechnology Course Needs

The introductory biotechnology course described in the pacing guide includes DNA electrophoresis, bacterial transformation, and PCR. These techniques require horizontal gel electrophoresis equipment, power supplies, micropipets, mini centrifuges, a water bath, an incubator, a thermal cycler, and various accessories. Tables 4, 5, and 10 list the necessary and optional supplies for this course.

The necessary kits and specialized biotechnology equipment are available from Bio-Rad (see Tables 4 and 5), while other equipment can be purchased from other vendors (see Table 10). Bio-Rad also offers packages for the required equipment and kits that can be ordered as single catalog numbers.

Note: Catalog numbers are subject to change.

Table 3. Basic laboratory equipment and supplies required for all biotechnology courses. Most supplies are available from scientific suppliers.

Equipment	Consumables	Reagents
Balances	50 ml conical tubes	Distilled water (dH ₂ O)
Beakers	Coverslips	Reagent alcohol (95% ethanol)
Bottle brushes	Foil	
Bunsen burners	Graph paper	
Computers with graphing and spreadsheet software, Internet connection, and printer	Laboratory marking pens	
Containers of various sizes	Laboratory soap	
Flasks (25 ml–1 L)	Laboratory tape	
Funnels and powder funnels	Microscope slides	
Graduated cylinders (10 ml–4 L)	Paper towel and laboratory tissue	
Heat-resistant and non-heat resistant reagent bottles (plastic and/or glass) with caps 50 ml–1 L	Paraffin film (for example, Parafilm wrap)	
Heat-resistant gloves	Plastic wrap	
Ice buckets	Razor blades or scissors	
Microscopes	Serological pipets (5–25 ml)	
Microwave	Weigh boats	
Pipet pumps or fillers	Autoclave tape (optional)	
Rulers		
Squirt bottles		
Test tube racks		
Test tubes (10–20 ml)		
Thermometers		
Waste containers (microbial, liquid, and bench top)		
Autoclave (optional)		
Cuvette racks (optional)		
Heat-resistant pads (optional)		
Inoculation loops (wire) (optional)		

Table 4. Bio-Rad kits and consumables for an introductory biotechnology course. Visit bio-rad.com or check with your local Bio-Rad sales representative for the most up-to-date purchasing information.

Item	Bio-Rad Catalog #	Quantity
Biofuel Enzyme Kit	1665035EDU	1 kit
Crime Scene Investigator PCR Basics Kit plus Small DNA Electrophoresis Reagent Pack	1662650EDU	1 kit
ELISA Immuno Explorer Kit	1662400EDU	1 kit
Forensic DNA Fingerprinting Kit	1660007EDU	1 kit
Genes in a Bottle Kit	1662300EDU	1 kit
GMO Investigator Kit plus Small DNA Electrophoresis Reagent Pack	1662550EDU	1 kit
Got Protein? Kit	1662900EDU	1 kit
IDEA Kit	1665075EDU	1 kit
Microbes and Health Kit	1665030EDU	1 kit
pGLO Bacterial Transformation Kit	1660003EDU	1 kit
Restriction Digestion and Analysis of Lambda DNA Kit	1660002EDU	1 kit
Size Exclusion Chromatography Kit	1660008EDU	1 kit
Cell culture tubes, 17 x 100 mm, sterile, 25	1660476EDU	1 bag
10x phosphate buffered saline (PBS), 100 ml	1662403EDU	1 bottle
10x Tris/glycine/SDS (TGS), 1 L*	1610732EDU	1 bottle
50x Tris/acetic acid/ EDTA (TAE), 1 L*	1610743EDU	1 bottle
<i>E. coli</i> strain HB101 K-12 bacteria, lyophilized*	1660408EDU	1 bottle
EDTA disodium dihydrate, 500 g	1610729EDU	1 bottle
LB agar powder, 500 g	1660472EDU	1 bottle
Certified molecular biology agarose, 25 g*	1613100EDU	1 bottle
Tris, 500 g	1610716EDU	1 bottle
Disposable plastic transfer pipets, nonsterile, 1 ml, 500	1660480EDU	1 box
Petri dishes, 60 mm, sterile, 500	1660470EDU	1 box
Colored 1.5 ml microcentrifuge tubes, 6 colors, 600	1660473EDU	1 box
Gel support film, for drying agarose gels, 50 (optional)	1702984EDU	1 bag
Sample loading dye, 5x, DNA electrophoresis, 1 ml (optional)*	1660401EDU	1 bottle
UVView 6x loading dye and stain, 1 ml (optional)	1665112EDU	1 bottle
Fast Blast DNA stain, 500x, 100 ml (optional)*	1660420EDU	1 bottle

* This material is needed for non kit-based activities in the introductory course. However, if the kits are purchased for the kit-based activities in the course, there is sufficient excess material in the kits for these non kit-based activities, so there is no need to purchase separately.

Table 5. Bio-Rad equipment and supplies for an introductory biotechnology course. Visit bio-rad.com or check with your local Bio-Rad sales representative for the most up-to-date purchasing information.

Item	Bio-Rad Catalog #	Quantity
T100 thermal cycler	1861096EDU	1
Temperature-controlled water bath	1660504EDU (120 V) 1660524EDU (220 V)	1
Mini incubation oven	1660501EDU (120 V) 1660521EDU (220 V)	1
Tube roller	1660711EDU (120 V) 1660721EDU (230 V) 1660722EDU (230 V, for the UK)	1
Long-wave UV lamp, requires 4 AA batteries	1660500EDU	8
Mini centrifuge	1660603EDU (120 V) 1660613EDU (220 V) 1660623EDU (220 V, for the UK)	2
Mini-Sub cell GT electrophoresis chambers with 7x10 cm tray and two 8-well combs	1664000EDU	4 systems
PowerPac Basic power supply	1645050EDU	2
Professional adjustable-volume digital micropipet, 100–1,000 µl	1660508EDU	8 pipets
Professional adjustable-volume digital micropipet, 20–200 µl	1660507EDU	8 pipets
Professional adjustable-volume digital micropipet, 2–20 µl	1660506EDU	8 pipets
Green racks, 5 per set	1660481EDU	2 sets
PCR tube rack, 5 per set	TRC0501EDU	2 sets
Jellyfish foam floating racks, 8 racks, 12 microcentrifuge tube wells	1660479EDU	1 pack
Gel staining trays, 4	1660477EDU	2 packs
TBR-35 tips, 2–200 µl, 1,000	2239347EDU	2 boxes
TBR-40 tips, 100–1,000 µl, 1,000	2239350EDU	1 box
Xcluda B tips, 2–20 µl, 960	2112006EDU	1 box
Xcluda D tips, 20–200 µl, 960	2112016EDU	1 box
Xcluda E tips, 100–1,000 µl, 960	2112021EDU	1 box
Digital dry bath (optional)	1660562EDU (120 V) 1660563EDU (230 V)	1
Gel Doc EZ system (optional)	1708270EDU	1
Gel Doc EZ white light sample tray (optional)	1708272EDU	1
Model 16K microcentrifuge (optional)	1660602EDU (120 V) 1660612EDU (220 V)	1
UltraRocker rocking platform (optional)	1660709EDU (120 V) 1660719EDU (220 V)	1
BR-2000 vortexer (optional)	1660610EDU (120 V) 1660611EDU (220 V) 1660621EDU (220 V, for the UK)	1
PCR tube adaptor for Model 16K microcentrifuge (optional)	1660620EDU	1

Advanced Biotechnology Course Needs

The advanced biotechnology course described in the pacing guide includes DNA and protein electrophoresis, western blotting, bacterial transformation, plasmid purification and quantitation, and PCR. These techniques require horizontal and vertical gel electrophoresis equipment, electrophoretic blotters, power supplies, micropipets, water and dry baths, microcentrifuges capable of at least 12,000 rpm, an incubator, a thermal cycler, and

various accessories. Tables 6, 7, and 10 list the necessary and optional supplies for this course.

The necessary kits and specialized biotechnology equipment are available from Bio-Rad (see Tables 6 and 7), while other equipment can be purchased from other vendors (see Table 10). Bio-Rad also offers packages for the required equipment that can be ordered as single catalog numbers.

Table 6. Bio-Rad kits and consumables for an advanced biotechnology course. Visit bio-rad.com or check with your local Bio-Rad sales representative for the most up-to-date purchasing information.

Item	Bio-Rad Catalog #	Quantity
Aurum Plasmid Mini Purification Module	7326400EDU	1 kit
Biofuel Enzyme Kit	1665035EDU	1 kit
Comparative Proteomics Kit I: Protein Profiler Module	1662700EDU	1 kit
Comparative Proteomics Kits I and II: Protein Profiler and Western Blot Module	1662850EDU	1 kit
ELISA Immuno Explorer Kit	1662400EDU	1 kit
Fish DNA Barcoding Kit	1665100EDU	1 kit
Genes in a Bottle Kit	1662300EDU	1 kit
GMO Investigator Kit plus Small DNA Electrophoresis Reagent Pack	1662550EDU	1 kit
Green Fluorescent Protein Chromatography Kit	1660005EDU	1 kit
IDEA Kit	1665075EDU	1 kit
Microbes and Health Kit	1665030EDU	1 kit
Microbial Culturing Module	1665020EDU	1 kit
pGLO Bacterial Transformation Kit	1660003EDU	1 kit
PV92 PCR Informatics Kit	1662100EDU	1 kit
Restriction Digestion and Analysis of Lambda DNA Kit	1660002EDU	1 kit
EZ Load 1 kb molecular ruler, 100 applications	1708355EDU	1 bottle
Disposable plastic transfer pipets, nonsterile, 1 ml, 500	1660480EDU	1 box
10x Tris/glycine/SDS (TGS), 1 L*	1610732EDU	1 bottle
Cell culture tubes, 17 x 100 mm, sterile, 25	1660476EDU	1 bag
Mini-PROTEAN TGX precast gels, 4–20%, 10 gels	4561093EDU	2 boxes
Mini-PROTEAN TGX Stain-Free precast gels, 4–20%, 10 gels (optional)	4568093EDU	2 boxes
50x Tris/acetic acid/EDTA (TAE), 1 L*	1610743EDU	1 bottle
Petri dishes, 60 mm, 500	1660470EDU	1 box
Ampicillin, lyophilized, 30 mg	1660407EDU	1 bottle
<i>E. coli</i> strain HB101 K-12 bacteria, lyophilized*	1660408EDU	1 bottle
EDTA disodium dihydrate, 500 g	1610729EDU	1 bottle

* This material is needed for non kit-based activities in the introductory course. However, if the kits are purchased for the kit-based activities in the course, there is sufficient excess material in the kits for these non kit-based activities, so there is no need to purchase these items separately.

Table 6. Bio-Rad kits and consumables for an advanced biotechnology course, Continued.

Item	Bio-Rad Catalog #	Quantity
EDTA disodium dihydrate, 500 g	1610729EDU	1 bottle
Fast Blast DNA stain, 500x, 100 ml*	1660420EDU	1 bottle
Inoculation loops, 10 µl, sterile, 80	1660471EDU	1 pack
LB agar powder, 500 g	1660472EDU	1 bottle
LB nutrient broth, sterile, 10 ml	1660421EDU	1 bottle
Colored 1.5 ml microcentrifuge tubes, 6 colors, 600	1660473EDU	1 box
Precision molecular mass standard, 100 applications	1708207EDU	1 bottle
Sample loading dye, 5x, DNA electrophoresis, 1 ml*	1660401EDU	1 bottle
UView 6x loading dye and stain, 1 ml (optional)	1665112EDU	1 bottle
Transformation solution, 15 ml	1660409EDU	1 bottle
Tris, 500 g	1610716EDU	1 bottle
Quartz cuvettes	1702504EDU	1–3
Conical centrifuge tubes, 15 ml, 50 (optional)	1660475EDU	1 bag
Gel support film, for drying agarose gels, 50 (optional)	1702984EDU	1 pack
Protease solution, 1.3 ml (optional)	1662003EDU	1 bottle

* This material is needed for non kit-based activities in the introductory course. However, if the kits are purchased for the kit-based activities in the course, there is sufficient excess material in the kits for these non kit-based activities, so there is no need to purchase these items separately.

Table 7. Additional Bio-Rad equipment and supplies for an advanced biotechnology course. Visit bio-rad.com or check with your local Bio-Rad sales representative for the most up-to-date purchasing information.

Item	Bio-Rad Catalog #	Quantity
Mini-PROTEAN Tetra cell systems	1658005EDU	4 systems
Mini Trans-Blot inner module	1703935EDU	4 modules
Storage boxes, set of 5 (optional)	1660482EDU	2
Gel staining trays, 4 (2 packs included in the introductory package)	1660477EDU	2 packs
UView Mini Transilluminator (optional)	1660531EDU	1–4
iMark microplate absorbance reader (optional)	1681130EDU	1

Needs for a Course with Minimal Equipment

The course with minimal equipment described in the pacing guide includes DNA electrophoresis, and bacterial transformation. These techniques require horizontal gel electrophoresis equipment, a power supply, micropipets, mini centrifuges, a water bath, incubator, and various accessories. Tables 8, 9, and 10 list the necessary and optional supplies for this course.

The necessary kits and specialized biotechnology equipment are available from Bio-Rad (see Tables 8 and 9), while other equipment can be purchased from other vendors (see Table 10). Bio-Rad also offers packages for the required equipment and kits that can be ordered as single catalog numbers.

Table 8. Bio-Rad kits and consumables for a biotechnology course using minimal equipment. Visit bio-rad.com or check with your local Bio-Rad sales representative for the most up-to-date purchasing information.

Item	Bio-Rad Catalog #	Quantity
Biofuel Enzyme Kit	1665035EDU	1 kit
ELISA Immuno Explorer Kit	1662400EDU	1 kit
Forensic DNA Fingerprinting Kit	1660007EDU	1 kit
Genes in a Bottle Kit	1662300EDU	1 kit
Got Protein? Kit	1662900EDU	1 kit
IDEA Kit	1665075EDU	1 kit
Microbes and Health Kit	1665030EDU	1 kit
pGLO Bacterial Transformation Kit	1660003EDU	1 kit
Restriction Digestion and Analysis of Lambda DNA Kit	1660002EDU	1 kit
Size Exclusion Chromatography Kit	1660008EDU	1 kit
Cell culture tubes, 17 x 100 mm, sterile, 25	1660476EDU	1 bag
10x phosphate buffered saline (PBS), 100 ml	1662403EDU	1 bottle
10x Tris/glycine/SDS (TGS), 1 L**	1610732EDU	1 bottle
50x Tris/acetic acid/ EDTA (TAE), 1 L*	1610743EDU	1 bottle
<i>E. coli</i> strain HB101 K-12 bacteria, lyophilized*	1660408EDU	1 bottle
EDTA disodium dihydrate, 500 g**	1610729EDU	1 bottle
LB agar powder, 500 g	1660472EDU	1 bottle
Certified molecular biology agarose, 25 g*	1613100EDU	1 bottle
Tris, 500 g**	1610716EDU	1 bottle
Disposable plastic transfer pipets, nonsterile, 1 ml, 500	1660480EDU	1 box
Petri dishes, 60 mm, 500	1660470EDU	1 box
Blank Disks, sterile, 50	1660468EDU	1 bottle
Colored 1.5 ml microcentrifuge tubes, 6 colors, 600	1660473EDU	1 box
Gel support film, for drying agarose gels, 50 (optional)	1702984EDU	1 bag
Sample loading dye, 5x, DNA electrophoresis, 1 ml (optional)*	1660401EDU	1 bottle
Fast Blast DNA stain, 500x, 100 ml (optional)*	1660420EDU	1 bottle

* This material is needed for non kit-based activities in the course using minimal equipment. However, if the kits are purchased for the kit-based activities in the course, there is sufficient excess material in the kits for these non kit-based activities, so there is no need to purchase these items separately.

** 10x Tris/glycine/SDS electrophoresis buffer, EDTA, and Tris are used in Activity 2.D to practice preparing solutions; they are not required for any other activity in this course.

Table 9. Bio-Rad equipment and supplies for a biotechnology course using minimal equipment. Visit bio-rad.com or check with your local Bio-Rad sales representative for the most up-to-date purchasing information.

Item	Bio-Rad Catalog #	Quantity
Temperature-controlled water bath	1660504EDU (120 V) 1660524EDU (220 V)	1
Mini incubation oven	1660501EDU (120 V) 1660521EDU (220 V)	1
Mini centrifuge	1660603EDU (120 V) 1660613EDU (220 V) 1660623EDU (220 V, for the UK)	1
Mini-Sub cell GT electrophoresis chambers with 7 x 10 cm tray and two 8-well combs	1664000EDU	4 systems
PowerPac Basic power supply	1645050EDU	1
Classroom adjustable-volume digital micropipet, 100–1,000 μ l	1660553EDU	1 pipet
Classroom adjustable-volume digital micropipet, 20–200 μ l	1660552EDU	1 pipet
Classroom adjustable-volume digital micropipet, 2–20 μ l	1660551EDU	8 pipets
Green racks, 5 per set	1660481EDU	2 sets
Jellyfish foam floating racks, 8 racks, 12 microcentrifuge tube wells	1660479EDU	1 pack
Gel staining trays, 4	1660477EDU	2 packs
TBR-35 tips, 2–200 μ l, 1,000	2239347EDU	2 boxes
TBR-40 tips, 100–1,000 μ l, 1,000	2239350EDU	1 box

Table 10. Other specialty equipment and consumables for all biotechnology courses.

Item	Quantity
Balances capable of measuring grams to 2 decimal places	1–4
Magnetic stirplates and stirbars (optional)	1–8
UV/Vis Spectrophotometer	1
pH meters and calibration buffers (optional)	1–8
Dropper bottles	32
Forceps	8
Magnifying glasses	8
Mortars and pestles	8
Wax pencils	8
Stage micrometers (optional)	1–8
Volumetric flasks, 100 ml	8
Burettes, 25 or 50 ml	8
Syringes, 10 ml	8
Petri dishes, 100 mm	8
pH paper (pH 4–7 or broader range)	64 pieces
Sep-Pak classic C18 cartridges*	8
Filter sterilization units, 100 ml (optional)	8
HCl, 1 M (or higher)	200 ml
NaOH, 4 M (or higher)	200 ml
2-Propanol (isopropanol), 91%, 95%, or 99.5%	1 L
Molecular biology grade ethanol, 95–100%**	100 ml
CaCl ₂	100 g
Chicken serum, freeze-dried***	1
Donkey anti-chicken IgY antiserum, freeze-dried†	1
Gram stain set	1
LB broth	100 ml
NaCl	100 g
Phenolphthalein	0.2 g
Sucrose	16 g

* Available from waters.com (catalog #WAT051910).

** Only necessary for Activity 5.C in the advanced course.

*** Available from jacksonimmuno.com (catalog #003-000-001).

† Available from jacksonimmuno.com (catalog #703-001-003).

Table 11a. Bio-Rad kits, consumables, and reagents requirements for each activity. Tables 11a, b, and c provide activity-specific requirements to help in designing a course. These equipment and supplies for each activity that are needed in addition to the basic laboratory equipment and supplies listed in Table 3. Note that catalog numbers are subject to change. Visit

Activity	Bio-Rad Kits	1 kb molecular ruler (catalog #1708355EDU)	Disposable plastic transfer pipets, nonsterile, 1 ml, (catalog # 1660480EDU)	10x PBS (phosphate buffered saline) (catalog #1662403EDU)	10x Tris/glycine/SDS electrophoresis buffer (catalog #1610732EDU)	Conical centrifuge tubes, 15 ml (catalog #1660475EDU)
Activity 2.A DNA Extraction and Precipitation	Genes in a Bottle kit (catalog #1662300EDU)					
Activity 2.B Pipetting	N/A		8			
Activity 2.D Making Solutions	N/A		24		500 ml	
Activity 2.E Titration	N/A		8			
Activity 3.A Making Microbiology Media	(Materials are listed with the activity where the media are used)					
Activity 3.B Disk Diffusion Test (Modified Kirby-Bauer Test)	N/A					
Activity 3.C Microbes and Health: An Illustration of Koch's Postulates	Microbes and health kit (catalog #1665030EDU)		8 (o)			
Activity 3.D Gram Staining	N/A					
Activity 3.E Quantifying Bacterial Numbers	N/A					
Activity 3.F Staining Eukaryotic Cells	N/A			5 ml		
Activity 4.B Casting Agarose Gels	(Materials are listed with the activity where the gels are used)					
Activity 4.C Dye Electrophoresis	IDEA kit (catalog# 1665075EDU)					
Activity 4.D Restriction Digestion and Analysis of Lambda DNA	Restriction digestion and analysis of lambda DNA kit (catalog #1660002EDU)					
Activity 4.E Forensic DNA Fingerprinting	Forensic DNA fingerprinting kit (catalog #1660007EDU)					
Activity 5.A Bacterial Transformation with S3 Plasmid						
Activity 5.B Bacterial Transformation with pGLO Plasmid	pGLO bacterial transformation kit (catalog #1660003EDU)					
Activity 5.C Purification of S3 and pGLO Plasmids	Microbial culturing module (catalog #1665020EDU) and Aurum plasmid mini purification kit (catalog #732-6400EDU)					
Activity 5.D DNA Quantitation	N/A		1 vial			
Activity 6.A STR PCR Analysis	Crime Scene Investigator PCR Basics kit plus small DNA electrophoresis reagent pack (catalog #1662650EDU)					
Activity 6.B GMO Detection by PCR	GMO Investigator kit plus small DNA electrophoresis reagent pack (catalog #1662550EDU)					
Activity 6.C Detection of the Human PV92 Alu Insertion	PV92 PCR informatics kit (catalog #1662100EDU)					
Activity 6.D Fish DNA Barcoding	Fish DNA Barcoding kit (catalog #1665100EDU)		32 (o)			
Activity 7.A Protein Quantitation Using the Bradford Assay	Got Protein? kit (catalog #1662900EDU)					9
Activity 7.B Size Exclusion Chromatography	Size exclusion chromatography kit (catalog #1660008EDU)					
Activity 7.C GFP Purification by Hydrophobic Interaction Chromatography (HIC)	Green fluorescent protein chromatography kit (catalog #1660005EDU)					
Activity 7.D SDS-PAGE of Fish Muscle	Comparative proteomics kit I: protein profiler module (catalog #1662700EDU)					
Activity 7.E Biofuel Enzyme Assay	Biofuel enzyme kit (catalog #1665035EDU)					
Activity 8.A Ouchterlony Double Immunodiffusion Assay	N/A		8	11 ml		
Activity 8.B Serum Antibody Detection by ELISA	ELISA Immuno Explorer kit (catalog #1662400EDU)					
Activity 8.C Quantitative ELISA	ELISA Immuno Explorer kit (catalog #1662400EDU)					2 (o)
Activity 8.D Western Blotting	Comparative proteomics kits I and II: protein profiler and western blot modules (catalog #166-2850EDU)					

* Activity 5.C requires eight 2.0 ml microcentrifuge tubes and 32 1.5 ml microcentrifuge tubes.

** A midrange UV transilluminator is required to activate Mini-PROTEAN

tables should be used together to determine what is required for each activity. Products available from Bio-Rad are outlined in Tables 11a and b. Table 11c lists non Bio-Rad specialty bio-rad.com or check with your local sales representative for the most up-to-date purchasing information. **Note:** (o) means the item is optional and not required for the activity.

Cell culture tubes, 17 x 100mm (catalog #1660476EDU)	4-20% Mini-PROTEAN® TGX gels (catalog #4561093EDU)	4-20% Mini-PROTEAN® TGX Stain-Free gels (catalog #4568093EDU)	50x Tris/acetate acid/EDTA (TAE) (catalog #1610743EDU)	Petri dishes, 60 mm, sterile (catalog #1660470EDU)	Blank disks, sterile (catalog #1660468EDU)	Agarose gel support film (catalog #1702984EDU)	Ampicillin, lyophilized (catalog #1660407EDU)	<i>E. coli</i> HB101 bacteria (freeze-dried), (catalog #1660408EDU)	EDTA disodium dihydrate (catalog #1610729EDU)	Fast Blast DNA stain, 500x (catalog #1660420EDU)	Inoculation loops (catalog #1660471EDU)	LB agar powder (catalog #1660472EDU)	LB broth, sterile (catalog #1660421EDU)	Microcentrifuge tubes (catalog #1660473EDU)	Certified molecular biology agarose (catalog #1613100EDU)	Precision molecular mass standard (catalog #1708207EDU)	Protease solution (for hair follicle protocol) (catalog #1662003EDU)	Sample loading buffer (catalog #1660401EDU)	UVView 6x loading dye and stain, 1ml (catalog #1665112EDU)	Transformation solution (catalog #1660409EDU)	Tris (catalog #1610716EDU)
			120 ml						150 g					24							50 g
														8							
8				8 (o)	32		1 vial	1 vial			8	10 g		25							
														16							
														8							
8				60				1 vial			56	30 g		56							
										1 ml											
			50 ml							2 µl (o)				8	4 g				0.2 ml (o)		
						8 (o)													100 µl (o)		
						8 (o)													200 µl (o)		
8 (o)				32			1 vial	1 vial			50	20 g	10 ml	48							5 ml
														40*							
			50 ml			8 (o)				2 ml				64	4 g	1 vial		500 µl	275 µl (o)		
																			440 µl (o)		
																			440 µl (o)		
																			640 µl (o)		
						8 (o)								32 (o)					23 µl (o)		
														24-96							
8	8 (o)																				
				10										40	1 g						
8	8 (o)																				

Table 11b. Bio-Rad equipment requirements for each activity. Tables 11a, b, and c provide activity-specific requirements to help in designing a course. These tables should be used each activity that are needed in addition to the basic laboratory equipment and supplies listed in Table 3. Note that catalog numbers are subject to change. Visit bio-rad.com or check with

Activity	2–20 µl adjustable-volume micropipet (catalog #1660506EDU)	20–200 µl adjustable-volume micropipet (catalog #1660507EDU)	100–1,000 µl adjustable-volume micropipet (catalog #1660508EDU)	Horizontal gel electrophoresis system (catalog #1664000EDU)	Microcentrifuge (catalog #1660602EDU (120 V)) or mini centrifuge (catalog #1660603EDU (120V))	Power supply (catalog #1645050EDU (120 V))	Shaking incubator or shaking water bath or incubator with tube roller (catalog #1660713EDU (120 V))	Gel staining trays (catalog #1660477EDU)	Incubator oven (catalog #1660601EDU (120 V))	Water bath (catalog #1660504EDU (120 V))	Water bath (catalog #1660504EDU (120 V)) or dry bath (catalog #1660562EDU (120 V))
Activity 2.A DNA Extraction and Precipitation											1
Activity 2.B Pipetting	8	8	8								
Activity 3.A Making Microbiology Media											1 (o)
Activity 3.B Disk Diffusion Test (Modified Kirby-Bauer Test)	8		8						1		
Activity 3.C Microbes and Health: An Illustration of Koch's Postulates		8 (o)							1		
Activity 3.E Quantifying Bacterial Numbers		8	8				1		1		
Activity 4.C Dye Electrophoresis	8	1		4–8		2–4					
Activity 4.D Restriction Digestion and Analysis of Lambda DNA	8	1	1	4–8	1–4 (o)	2–4		8			
Activity 4.E Forensic DNA Fingerprinting	8	1	1	4–8	1–4 (o)	2–4		8			
Activity 5.A Bacterial Transformation with S3 Plasmid	8	8	8						1	1	
Activity 5.B Bacterial Transformation with pGLO Plasmid	8 (o)	8 (o)	8 (o)						1	1	
Activity 5.C Purification of S3 and pGLO Plasmids		8	8				1				
Activity 5.D DNA Quantitation	8	1		4–8		2–4		8			
Activity 6.A STR PCR Analysis	8	1	1	4–8	1–4 (o)	2–4		8			
Activity 6.B GMO Detection by PCR	8	1	1	4–8	1–4	2–4		8			1
Activity 6.C Detection of the Human PV92 Alu Insertion	8	1	1–8 (o)	4–8	1–4	2–4		8			2
Activity 6.D Fish DNA Barcoding	8	8	8	4–8	1–4	2–4		4			
Activity 7.A Protein Quantitation Using the Bradford Assay	8	8	8								
Activity 7.B Size Exclusion Chromatography											
Activity 7.C GFP Purification by Hydrophobic Interaction Chromatography (HIC)		8 (o)	8 (o)		1–4		1		1		
Activity 7.D SDS-PAGE of Fish Muscle	8		8			2–4		8			1
Activity 7.E Biofuel Enzyme Assay			8 (o)		1–4 (o)						1–4
Activity 8.A Ouchterlony Double Immunodiffusion Assay	8		1		1						
Activity 8.B Serum Antibody Detection by ELISA		8									
Activity 8.C Quantitative ELISA		8									
Activity 8.D Western Blotting	8		8			2–4		16			1

* The number of tips for each activity varies. A box refers to the minimal unit available for purchase (960–1,000 tips). Refer to Tables 7, 9, and 11 for estimates on tip requirements for biotechnology courses.

** A UV transilluminator or gel imaging system capable of emitting midrange UV wavelengths is required to activate Mini-PROTEAN® TGX Stain-Free gels.

together to determine what is required for each activity. Products available from Bio-Rad are outlined in Tables 11a and b. Table 14c lists non Bio-Rad specialty equipment and supplies for your local Bio-Rad sales representative for the most up-to-date purchasing information. **Note:** (o) means the item is optional and not required for the activity.

														Optional				
Water bath (catalog #1660504EDU) or dry bath (catalog #1660562EDU (120 V)) or incubator (catalog #1660501EDU (120 V))																		
Microcentrifuge tube rack (catalog #1660481EDU)																		
UV light (catalog #1660500EDU)																		
Floating tube rack (catalog #1660479EDU)																		
Pipet tips, 2–200 µl, box** (catalog #2239347)																		
Pipet tips, 100–1,000 µl, box** (catalog #2239350)																		
Aerosol barrier pipet tips, 2–20 µl, box** (catalog #2112006EDU)																		
Aerosol barrier pipet tips, 20–200 µl, box** (catalog #2112016EDU)																		
Aerosol barrier pipet tips, 100–1,000 µl, box** (catalog #2112021EDU)																		
Thermal cycler (catalog #1861096EDU (120 V))																		
PCR tube rack (catalog #TRC0501EDU)																		
Microcentrifuge (>10,000 rpm) (catalog #1660602EDU (120 V))																		
Adapters for PCR tubes (catalog #1660620EDU)																		
Mini-PROTEAN Tetra cell system (catalog #1668005EDU) or vertical electrophoresis chambers																		
Mini Trans-Blot module (catalog #1703935EDU) or electroblotting apparatus																		
Rocking platform (catalog #1660709EDU (120 V))																		
Vortexer (catalog #1660610EDU (120 V))																		
Digital imaging system (catalog #1708270EDU (120 V) and #1708272EDU)																		
UV transilluminator* (catalog# 1660531EDU)																		
Microplate absorbance reader (catalog #1681130EDU (120 V))																		
	8 (o)																	
	8			1	1													
				1	1													
			1 (o)															
			1	1														
	8		1															
1	8	8 (o)	1	1										1–4 (o)			1–4 (o)	1–4 (o)
1	8	8 (o)	1	1										1–4 (o)			1–4 (o)	1–4 (o)
	8	4–8	1	1														
	8	8	1 (o)	1 (o)														
	8		1	1														
	8		1							1								1–4 (o)
	8		1											1–4 (o)				1–4 (o)
	8				1	1	1	1	8 (o)		1–4 (o)			1–4 (o)			1–4 (o)	1–4 (o)
	8	4–8 (o)			1	1	1	1	8 (o)		1–4 (o)			1–4 (o)			1–4 (o)	1–4 (o)
	8	4–8 (o)			1	1	1	1	8 (o)		1–4 (o)			1–4 (o)			1–4 (o)	1–4 (o)
	8		1	1	1	1		1	8	1–4								1
			1	1														
	8																	
	8	8	1 (o)	1 (o)														
	8	8 (o)	1	1 (o)										4		1–4 (o)		1–4 (o)**
	8	8 (o)		1 (o)														
	8		1	1														
	8		1															
	8		1															1 (o)
	8	8 (o)	1	1										4	4 (o)	1–4		1–4 (o)

Table 11c. Non Bio-Rad specialty equipment and supplies for each activity. Tables 11a, b, and c provide activity-specific requirements to help in designing a course. These tables should be used together to determine what is required for each activity. Products available from Bio-Rad are outlined in Tables 11a and b. Table 14c lists non Bio-Rad specialty equipment and supplies for each activity that are needed in addition to the basic laboratory equipment and supplies listed in Table 3.

Activity	Non Bio-Rad Reagents/Consumables	Non Bio-Rad Equipment
Activity 2.B Pipetting		Balances capable of measuring grams to 2 decimal places, 1–4; Pipet pumps or fillers (optional), 8
Activity 2.C Kool-Aid Column Chromatography	Sep-Pak classic C18 cartridges*, 8; 10 ml syringes, 8; 2-Propanol (isopropanol), 91%, 95% or 99.5%, 1 L	Pipet pumps or fillers (optional), 8
Activity 2.D Making Solutions	Filter sterilization units, 100 ml, 16 (optional); HCl, 1 N (or higher), 200 ml; NaOH, 4 N (or higher), 200 ml; CaCl ₂ , 100 g; NaCl, 100 g	Volumetric flasks, 100 ml, 8; Magnetic stirplates and stirbars (optional), 1–8; pH meters and calibration buffers, 1–8; Pipet pumps or fillers (optional), 8; Balances, 1–4; Autoclave (optional), 1
Activity 2.E Titration	Phenolphthalein, 0.2 g; NaOH, 0.4 N (or higher), 500 ml; HCl, 0.1 N (or higher), 500 ml	Magnetic stirplates and stirbars (optional), 1–8; Burettes, 25 or 50 ml, 8; Stands and clamps, 8
Activity 3.A Making Microbiology Media		Autoclave and autoclave tape (optional) 1; Microwave ovens, 1–4; Balances, 1–4
Activity 3.B Disk Diffusion Test (Modified Kirby-Bauer Test)	Petri dishes, 100 mm, 8; Filter paper (Whatman #1), 1 sheet; LB broth, 16 ml	Forceps, 8; Autoclave and autoclave tape (optional), 1
Activity 3.C Microbes and Health: An Illustration of Koch's Postulates	pH paper (pH 4–7 or broader range), 64 pieces; Magnifying glasses, 8; Sucrose, 16 g	Microscope and accessories, 8; Bunsen burners (optional), 8
Activity 3.D Gram Staining	Wax pencils, 8; Gram stain kit, 1	Dropper bottles (optional), 32; Stage micrometers (optional), 1–8; Microscope and accessories, 8
Activity 3.E Quantifying Bacterial Numbers	LB broth, 100 ml	Bunsen burners (optional), 8
Activity 3.F Staining Eukaryotic Cells	Lugol's iodine, 10 ml; Janus green B stain (1% solution), 10 ml	Dropper bottles (optional), 24; Stage micrometers (optional), 1–8; Microscope and accessories, 8
Activity 4.B Casting Agarose Gels		Microwave ovens, 1–4; Balances, 1–4
Activity 4.C Dye Electrophoresis	Colored hard shell candies and/or powdered drink mixes	
Activity 5.A Bacterial Transformation with S3 Plasmid		5–15 ml glass or sterile screwcap tubes for agar deeps (optional), 8; Bunsen burners (optional), 8
Activity 5.B Bacterial Transformation with pGLO Plasmid		5–15 ml glass or sterile screwcap tubes for agar deeps (optional), 8; Bunsen burners (optional), 8
Activity 5.C Purification of S3 and pGLO Plasmids	Molecular biology grade ethanol, 95–100%, 100 ml	Pipet pumps or fillers, 8; Bunsen burners (optional), 8
Activity 5.D DNA Quantitation		UV/Vis Spectrophotometer, 1
Activity 6.B GMO Detection by PCR		Mortars and pestles, 8–16; Balances, 1–4
Activity 6.C Detection of the Human PV92 Alu Insertion		Tweezers or forceps (optional), 8; Razor blades or scissors (optional), 8–32
Activity 6.D Fish DNA Barcoding		Microwave ovens, 1–4
Activity 7.A Protein Quantitation Using the Bradford Assay		Pipet pumps or fillers (optional), 1
Activity 7.C GFP Purification by Hydrophobic Interaction Chromatography (HIC)		Pipet pumps or fillers (optional), 8; Bunsen burners (optional), 8
Activity 7.4 SDS-PAGE of Fish Muscle		Razor blades or scissors, 8
Activity 7.E Biofuel Enzyme Assay		Mortars and pestles, 8; Balances, 1–4; Pipet pumps or fillers, 1
Activity 8.A Ouchterlony-Double Immunodiffusion Assay	Chicken serum**, 1 vial; Donkey anti-chicken IgY antiserum**, 1 vial	Microwave oven, 1; Balance, 1; Razorblades or scissors, 8
Activity 8.D Western Blotting		Rollers, 8; Razorblades or scissors, 8

* Sep-Pak classic C18 cartridges are available from Waters corporation (catalog #WAT051910) at waters.com

** Chicken serum and donkey anti-chicken IgY antiserum are available from Jackson Immuno Research Laboratories Inc (catalog #003-000-001 and #703-001-003, respectively) at jacksonimmuno.com

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