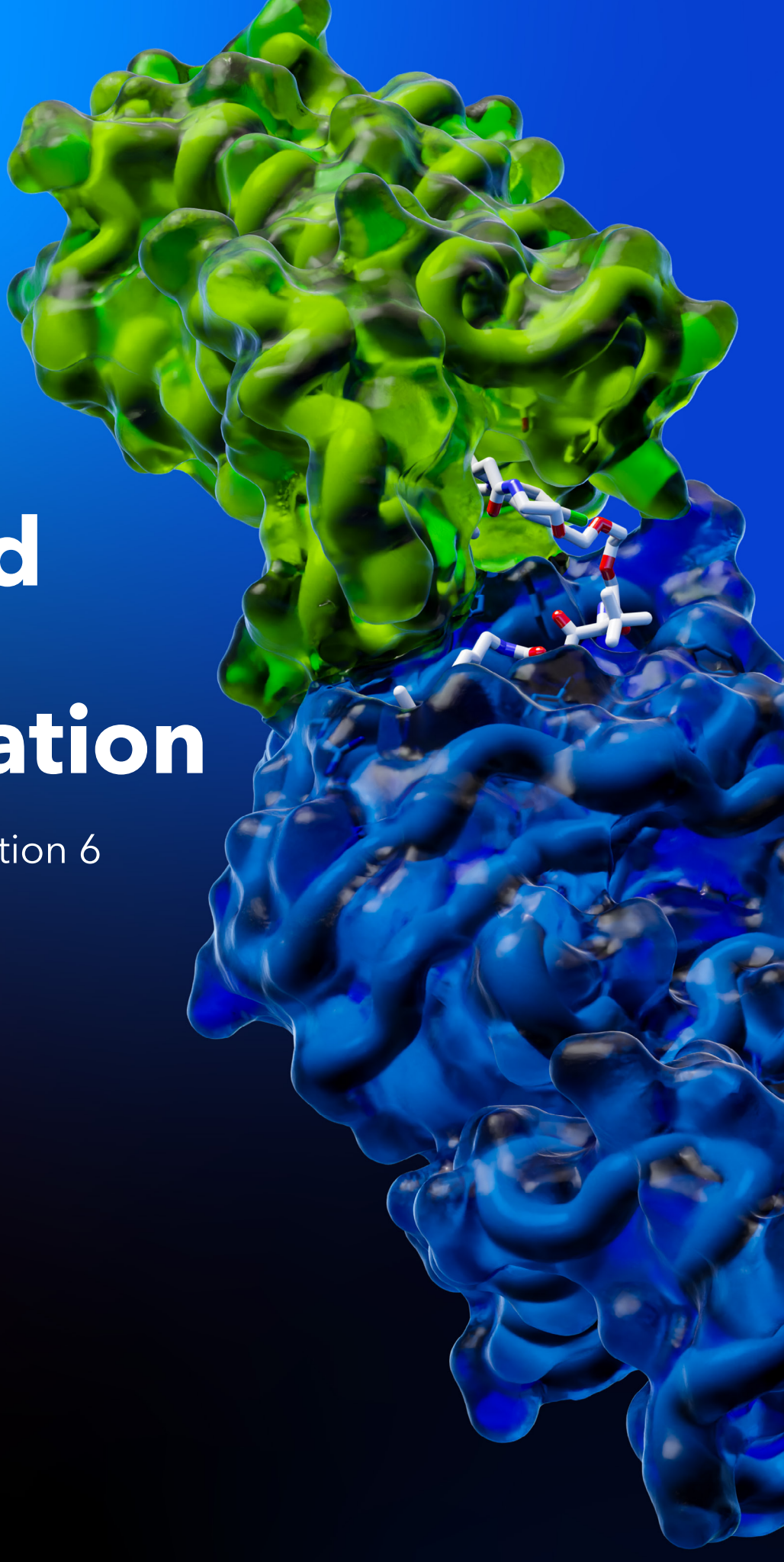
Targeted Protein Degradation

Product Guide | Edition 6



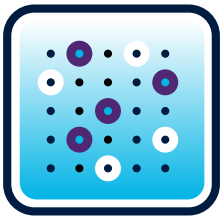
bio-techne®

Targeted Protein Degradation

The Bio-Techne family of brands offer a unique portfolio of high-quality reagents, instruments and services for researchers working in the rapidly growing field of Targeted Protein Degradation (TPD). Our bespoke range of tools and reagents includes small molecule Protein Degraders; TAG Degradation Platform, including dTAG, aTAG and BromoTag® Degraders; Degrader Building Blocks; Assays for Protein Degradation; Ubiquitin-Proteasome System Proteins and Assays; and Custom Degrader Services. Visit bio-techne.com/tpd to learn more about our workflow solutions to support your TPD research.

Target exploration and validation

Degrader design and synthesis



Assays for targeted protein degradation

E3 ligase and ubiquitin proteasome system biology

Contents

Introduction to Targeted Protein Degradation

The use of heterobifunctional small molecule Degraders (e.g. PROTAC® molecules, SNIPERs etc) to elicit TPD, is an area of increasing research interest. The approach employs two small molecules joined by a linker. One binds to the target protein of interest (POI), the other binds and recruits an E3 ligase to form a ternary complex. This initiates the ubiquitination of the POI and its subsequent destruction by the proteasome. There are a number of significant benefits to using this technology. Efficient and highly selective protein knock-down can be achieved both *in vitro* and *in vivo*. Degraders act catalytically by repeatedly engaging and directing the ubiquitination of the POI and can therefore be used at very low doses to achieve sustained knock-down. Bio-Techne offers a range of products and services to support your research in this field.

Mechanism of Degrader Action

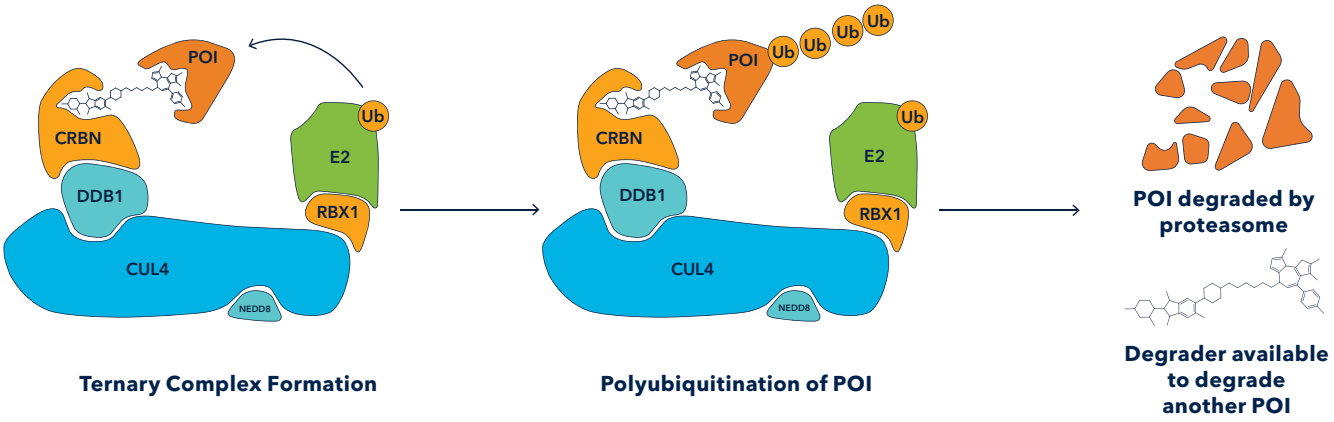


FIGURE 1: Schematic showing the catalytic mode of action of heterobifunctional degrader molecules. Degraders initiate the formation of a ternary complex between an E3 ubiquitin ligase, such as cereblon, and a target protein of interest (POI), which results in polyubiquitination of the target protein, its recognition by the proteasome and subsequent degradation.

As an approach for target protein knockdown within cells, Degraders offer several advantages over genetic manipulation:

- **Ease of use**: Degraders are cell-permeable small molecules that can be applied directly to cells, with no need for transfection or expression vectors.
- **Applicable to multiple cells lines**, with no requirement that cells are easily transfectable.
- **Duration of effect is adjustable and reversible** on compound washout.
- **Catalytic mode of action**, allowing use at sub-stoichiometric concentrations.

Target Exploration and Validation

Active Degraders

Bio-Techne has pioneered commercialization of tool Protein Degraders to make them available to the research community. They provide an easy-to-use alternative to genetic manipulation for investigating phenotypic consequences of target protein knockdown. A selection of our growing range is provided in the table below, and the full range is available through our website: www.bio-techne.com/research-areas/targeted-protein-degradation/protein-degraders.

Bio-Techne is also constantly developing new antibodies to help you evaluate the efficacy of your degrader. The antibodies listed in the table below are suitable for Western Blot and most have been validated for our Simple Western™ instruments (more information on gel-free, blot-free and hands-free Western Blot can be found on page 14).

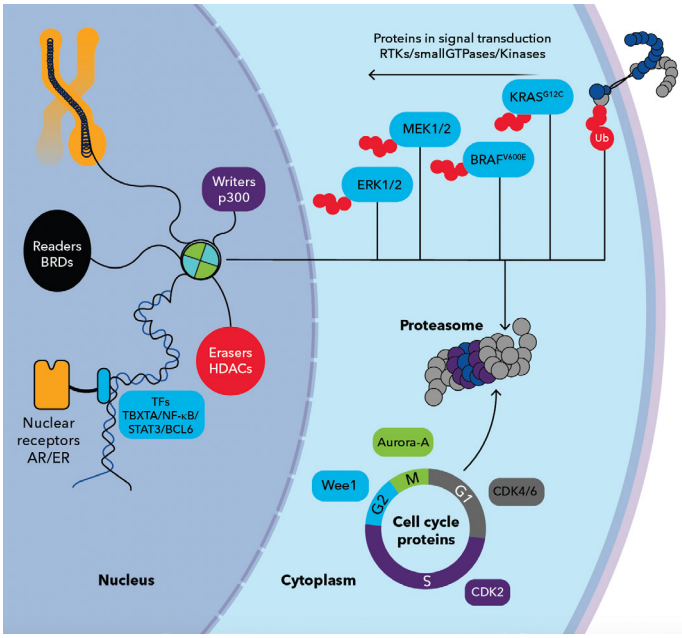


FIGURE 2: An overview of TPD targets degraded by the proteasome.

Target Protein	Product Name	Catalog #	Negative Control Available	Simple Western™ Validated Antibody	Western Blot Validated Antibody*
Adrenergic Receptors	α1A-AR Degrader 9c	7278		Coming Soon	MAB10298
ALK	TL 13-112	6745	Y	AF4210	AF4210
	TL 13-12	6744	Y		
Androgen Receptor and mutants	ARCC 4	7254	Y	MAB58762	MAB58762
Aurora A	JB 300	7837		AF3295, NBP1-51843	AF3295, NBP1-51843
BCR-Abl	GMB 475	7265			

Target Protein	Product Name	Catalog #	Negative Control Available	Simple Western™ Validated Antibody	Western Blot Validated Antibody*
BET Bromodomains: BRD2, BRD3, BRD4	ARV-771	7256		BRD4 -NBP1-86640	BRD4 - NBP1-86640
	AT 1	6356			
	BRD PHOTAC-I-3	7319		Coming soon	BRD2-NBP1-30475, NBP2-75422
	dBET1	6327		Coming soon	BRD3- NBP2-77359
	dBET6	6945			
	MZ 1	6154	Y		
	SIM 1	7432	Y		
	ZXH 3-26	6713			
BRD9	dBRD9	6606		BRD9 - NBP3-14730	BRD9 - NBP3-14730
BRD9	dBRD9-A	6943		NBP3-14730	NBP3-14730
BRD7/9	VZ 185	6936	Y	BRD7 coming soon	BRD7- NBP1-28727
BRAF and mutants	CG 858	7427	Y	AF3424	AF3424
	SJF 0628	7463	Y		
	CST 905	7745			
BTK	DD 03-171	7160			MAB5807, NBP2-02472
β-Catenin	xStAx-VHLL	7298		AF1329, NBP1-54467	AF1329, NBP1-54467
CDK6	BSJ-03-123	6921	Y	Coming soon	NBP1-87262
CDK4/6	BSJ-03-204	6938		CDK-4 AF5254, NBP1-31308	CDK-4 AF5254, NBP1-31308
CDK8	JH-XI-10-02	7304		Coming soon	NBP2-92972
CDK9	THAL SNS 032	6532		Coming soon	NBP2-15848, NBP3-15345
CDK9-cyclin T1 complex	LL-K9-3	7813			
CDK12	BSJ-4-116	7528		Coming soon	
cMET	SJF 8240	7266		Coming soon	AF276, MAB5694
CRBN	CRBN-6-5-5-VHL	6948		NBP1-91810	NBP1-91810
	CRBN PROTAC 14a	7219			

Target Protein	Product Name	Catalog #	Negative Control Available	Simple Western™ Validated Antibody	Western Blot Validated Antibody*
EGFR and mutants	Gefitinib-based PROTAC® 3	7258			
	MS 154	7395	Y	AF231	AF231
	MS 39	7397	Y		
	SJF 1521	7261			
	SJF 1528	7262			
EP300	JQAD1	7682		AF3789	AF3789
Estrogen Receptor	SNIPER (ER)-87	7120		AF5715, MAB57151	AF5715, MAB57151
FAK	FC 11	7306		AF4467, MAB4467	AF4467, MAB4467
	GSK 215	7818			
GSK3	PT-65	7651			GSK-3 beta NBP1-47470
					Alpha/beta-AF2157
HDAC4	HDAC4 CHDI Degrader 11	7882		NBP2-22151	
JAK2	SJ 1008030	7675		Coming Soon	NBP2-59451, AF2988
JAK2/3	SJ 10542	7727		Coming Soon	Jak3-MAB4699
$KRAS^{G12C}$	LC 2	7420	Y		
LCK	SJ 11646	7721		AF3704, MAB37041	AF3704, MAB37041
MIF	MD13	7504	Y	AF-289-PB, MAB289	AF-289-PB, MAB289
Mitochondria	AUTAC4	7699			
Multikinase	TL 12-186	6524	Y		
NAMPT	NAMPT PROTAC® A7	7842		AF4335, MAB40441	AF4335, MAB40441
p38 MAPK	NR 7h	7177		p38 a- AF8691	
	SJFδ	7267			
	SJFα	7268		P38 g – AF1347, MAB1347	
PARP1	SK 575	7583	Y	AF-600-NA, MAB8095	AF-600-NA, MAB8095
PRC2	UNC 6852	7816			
SRC-1	ND1-YL2	7388		AF3389, NBP1-19188	AF3389, NBP1-19188
STING	STING Degrader SP23	8053	Y	AF6516, NBP3-18816	AF6516, NBP3-18816

Target Protein	Product Name	Catalog #	Negative Control Available	Simple Western™ Validated Antibody	Western Blot Validated Antibody*
TBK1	TBK1 PROTAC 3i	7259	Y	AF9934, NB100-56705	AF9934, NB100-56705
TRIM24	dTRIM 24	6607			
TRK	CG 428	7425	Y	AF1494, AF397	AF1494, AF397
VHL	CM 11	6416	Y	Coming Soon	Coming Soon
Wee1	ZNL 02-096	7240	Y		NBP1-33506

*Additional options available at novusbio.com.

Related Small Molecules

Bio-Techne also offers a range of related reagents for the Ubiquitin-Proteasome System. A selection of related products is listed below.

Product Name	Catalog #	Action
Bortezomib	7282	High affinity proteasome inhibitor
Lactacystin	2267	Cell-permeable, potent and selective proteasome inhibitor
MG 132	1748	Proteasome and calpain inhibitor. Inhibits NF-κB activation
MLN 4924	6499	Potent and selective NEDD8 activating enzyme (NAE) inhibitor
Nutlin 3	3984	MDM2 antagonist; inhibits MDM2-p53 interaction
Thalidomide	0652	Binds cereblon; also TNF–α synthesis inhibitor
VH 298	6156	High-affinity inhibitor of VHL

To discuss potential licensing opportunities for Degraders and related products, please contact our licensing team at | licensing@bio-techne.com

TAG Degradation Platform

Tag, Degrade, Discover

The TAG Degradation Platforms (dTAG, aTAG and BromoTag®) are TPD based approaches to target validation that use a heterobifunctional Degrader targeting a TAG domain that is expressed as a fusion with a POI. This technology allows rapid and highly selective degradation of a POI, without the requirement of developing a specific Degrader for each target protein, and offers a valuable approach to validate targets for which there is no known ligand. The technology is generalizable to a range of fusion proteins.

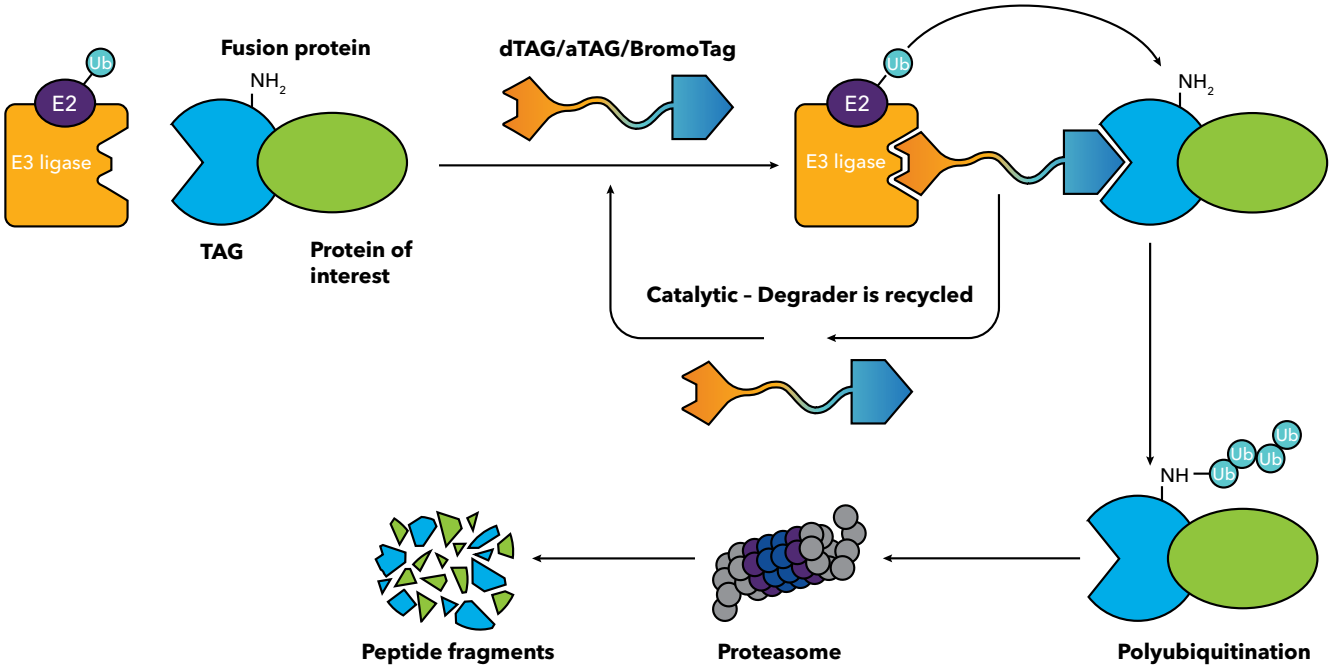


FIGURE 3: Schematic showing the mode of action of dTAG/aTAG /BromoTag Degraders. A POI is expressed as a fusion with a "TAG" protein. For the dTAG system the protein of interest is tagged with single-point mutant FKBP12 (F36V); the aTAG system uses MTH1 as the TAG; and the BromoTag system utilizes the TAG domain $Brd4^{BD2\ L387A}$. The TAG Degrader, which comprises a ligand that selectively binds the TAG protein linked to an E3 ligase ligand, initiates the formation of a ternary complex between an E3 ubiquitin ligase and the fusion protein which results in polyubiquitination of the target protein, its recognition by the proteasome and subsequent degradation of the entire fusion protein. dTAG/aTAG /BromoTag molecules act catalytically, repeatedly engaging and directing the ubiquitination of target molecules.

TAG Degradation is a promising alternative to genetic methods for target validation and can be used in cell culture or *in vivo*. The table below provides a comparison of TAG Degradation with commonly used genetic knockout/knockdown approaches.

	Dose Tuneability	Efficacy	Reversibility	Kinetics	Selectivity
TAG Degradation Platform (dTAG/aTAG/BromoTag)	***	****	****	***	****
Gene knockout e.g. CRISPR/Cas9	*	****	*	*	****
Gene knockdown e.g. RNAi	*	***	*	*	**

Bio-Techne offers several options for TAG Degradation, including dTAG, aTAG and BromoTag. The difference between them is the TAG protein. All can be used *in vitro* and *in vivo*.

TAG fusion proteins can be generated using genome engineering techniques such as transgene expression or CRISPR-Cas9-mediated locus-specific knock-in. See individual product listings for plasmid availability/ CRISPR protocol.

Platform	TAG Domain	TAG Degraders	Negative Controls	Related Products
dTAG	FKBP12^{F36V}	**CRBN recruiting:** • dTAG-13 (Cat. No. 6605) • dTAG-7 (Cat. No. 6912) • dTAG-47 (Cat. No. 7530) **VHL recruiting:** • dTAG^{V}-1 (Cat. No. 6914) • dTAG^{V}-1 hydrochloride– Formulation of dTAGV-1 specifically for use *in vivo* (Cat. No. 7374)	• dTAG-13-NEG (Cat. No. 6916) • dTAGV-1-NEG (Cat. No. 6915) • dTAG-47-NEG (Cat. No. 7531)	dTAG-Biotin (Cat. No. 7883) dTAG-Fluorescein (Cat. No. 7892)
aTAG	MTH1	**Cereblon recruiting:** • aTAG 2139 (Cat. No. 6970) • aTAG 4531 (Cat. No. 6971)	aTAG 2139-NEG (Cat. No. 7575)	
BromoTag	Brd4$^{BD2\ L387A}$	**VHL recruiting:** • BromoTag® AGB1 (Cat. No. 7686) • BromoTag® AGB3 (Cat. No. 7688)	BromoTag® cis-AGB1 (Cat. No. 7687)	NBP3 -17999 Coming soon: BromoTag® Fluorescein BromoTag® Janelia Fluor®
AID2	OsTIR1^{F74G}	**Skp 1 recruiting:** • 5-Ph-IAA (Cat. No. 7392) • 5-Ph-IAA-AM (Cat. No. 7893)		
Other	Brd4$^{BD1\ L94V}$	**Cereblon recruiting:** • XY-06-007 (Cat. No. 7669)		

BromoTag® AGB1 (Cat. No. 7686)

- Highly selective and potent "Bump & Hole" TAG Degrader (DC_{50}, 6h < 15nM)
- Recruits VHL to selectively degrade proteins tagged with the BromoTag domain: Brd4$^{BD2\ L387A}$
- Suitable for *in vitro* and *in vivo* applications
- A polyclonal antibody targeting Brd4$^{BD2\ L387A}$ (Cat. No. NBP3-17999) is available from Novus Biologicals for detection of Degrader-induced protein knockdown
- The three TAG platforms: BromoTag, dTAG and aTAG are orthogonal and have potential to be used in tandem

Gene Engineering Services

Bio-Techne offers fully customizable cell line development services that utilize our innovative non-viral gene delivery system TcBuster™. We can create custom cell lines expressing your TAG-POI fusion at comparable levels to unmodified protein. For more information visit: https://www.bio-techne.com/services/gene-engineering-services

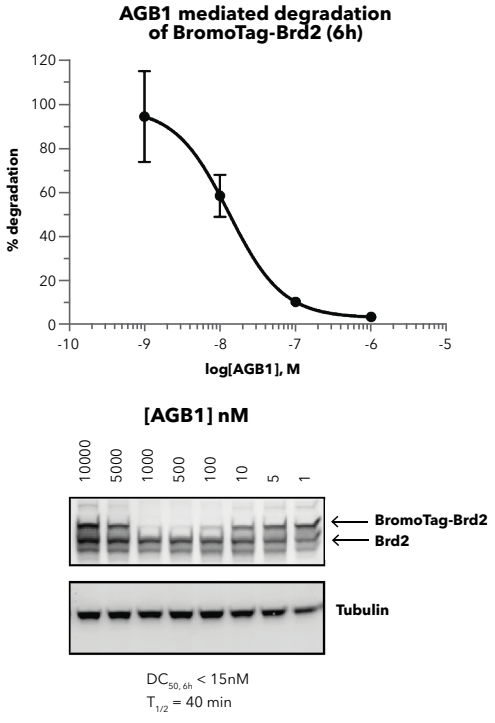


FIGURE 4: (Top) Dose-response curve of BromoTag-Brd2 expression upon a 6 h treatment of AGB1. (Bottom) Western blot titration of AGB1 treated heterozygous BromoTag-Brd2 HEK293 cells.

Degrader Design and Synthesis

PROTAC® Panel Builder

Degrader Discovery Just Got Easier!

We have made Degrader development easier with our PROTAC® Panel Builder online tool. You can use it to quickly select a bespoke collection of functionalized E3 ligase ligands plus linkers for your Degrader development project. View the panel builder at: https://www.tocris.com/protac-panel-builder.

Select your preferred panel of Degrader building blocks, and we will send you a quote. From mg to g scale, we offer unparalleled quality and customer service.

- E3 ligase ligands plus exit vectors (targeting VHL, Cereblon or IAP)
- Linkers (PEG or alkyl chains of variable length)
- Functional groups to couple to your target ligand of interest

Select E3 Ligase Ligand + exit vector + **Select Linkers** + **Select Functional Group** = **Review Structures**

- ○ Thalidomide 4′-oxyacetamide
- ○ Thalidomide 4′
- ○ Thalidomide 5′-amide
- ○ Lenalidomide 4′
- ● Pomalidomide 4′
- ○ A 410099.1 amide
- ○ LCL 161 phenol
- ○ VH 032 phenol
- ○ VH 032 amide
- ○ VH 101 phenol
- ○ 5′-Fluoro pomalidomide
- ○ Phenyl-glutarimide 4′-oxyacetamide

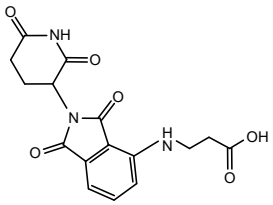
→

- ☐ PEG1
- ☐ PEG2
- ☐ PEG3
- ☐ PEG4
- ☐ PEG5
- ☐ PEG6
- ■ alkylC2
- ■ alkylC3
- ☐ alkylC4
- ☐ alkylC5
- ☐ alkylC6
- ☐ alkylC7
- ☐ alkylC8
- ☐ alkylC9
- ☐ alkylC10

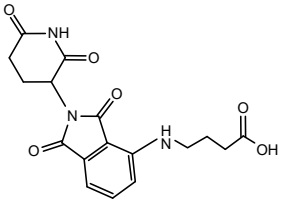
→

- ○ amine
- ● acid
- ○ alkyne
- ○ azide
- ○ alcohol

→



Request Quote



View PROTAC® Panel Builder | tocris.com/protac-panel-builder

Degrader Building Blocks

Develop Your Degraders with Our Toolbox of Functionalized Building Blocks

Bio-Techne also supplies off-the-shelf chemical building blocks (functionalized E3 ligase ligands plus linkers) to enable researchers to develop their own Degraders. Our Degrader components have functional handles for easy conjugation to ligands/linkers of interest. The range includes the most effective and commonly used E3 ubiquitin ligase ligands, functionalized at positions known not to interfere with binding affinity. E3 ligase ligands conjugated to common linker groups are also supplied.

The spectrum of Degrader building blocks that we offer is summarized in **FIGURE 5** below.

Check out the full range: bio-techne.com/research-areas/targeted-protein-degradation/degrader-building-blocks

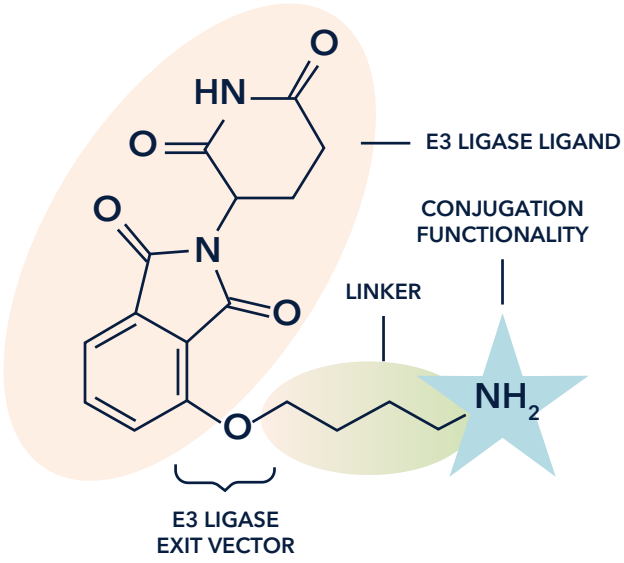


FIGURE 5: Example of Degrader building block available off-the-shelf.

E3 Ligase Ligand

A range of ligands are available for the most commonly recruited E3 ligases for TPD.

CRBN
- Pomalidomide
- Thalidomide (4′ and 5′)
- Lenalidomide
- PG
- PD
- tDHU

VHL
- VH 032
- VH 101

IAP
- A 410099.1
- LCL 161
- CST 530

DCAF1
- VH 543

L3MBTL3
- UNC 1215

DCAF16
- KB02

Negative control ligands available.

Conjugation Functionality

Amine, Carboxylic acid, Azide, Alkyne, Alcohol

Linkers are functionalized with a reactive chemical 'handle' to enable coupling to your target ligand of interest.

Linkers

Alkyl C2-C10, PEG1-PEG6, Rigid linkers

The choice and length of linker is critical for achieving optimal formation of the ternary complex. It is also a key determinant of the physiochemical properties of the final Degrader molecule. The majority of Degraders for proof-of-concept studies use either a PEG or alkyl linker, while introducing rigid linkers such as piperazines can potentially improve the properties of second-generation Degraders.

E3 Ligase Exit Vector

The exit vector bridges the E3 ligand to the linker group. Degrader building blocks are available with different exit vectors at various positions on the E3 ligase ligand.

Contact us for advice, support, bulk quantities and custom projects for developing novel Degraders
tpd@bio-techne.com

Assays for Targeted Protein Degradation

Successful development of small molecule Degraders requires a set of assays that explore target engagement by the Degrader, ternary complex formation, target protein ubiquitination and degradation, as well as downstream effects of protein knockdown.

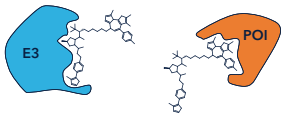
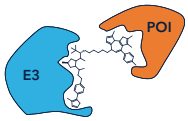
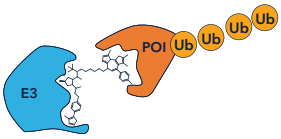
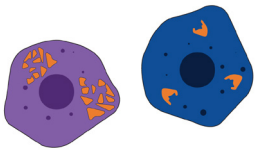
		Assays for Degrader Development	Available Reagents/ Platforms
	**Target Engagement**	**Fluorescence polarization (FP), time-resolved fluorescence resonance energy transfer (TR-FRET)**: Amenable to high-throughput operation. Applied for determination of binary and ternary binding affinity	CoraFluor™ TR-FRET reagents, fluorescent tracers and labelled antibodies available from Novus Biologicals
	**Ternary Complex Formation**	**FP, TR-FRET**: Amenable to high-throughput operation. Applied for determination of cooperativity of ternary complex formation	CoraFluor™ TR-FRET reagents, fluorescent tracers and labelled antibodies available from Novus Biologicals
	**Ubiquitination**	***In vitro* ubiquitination**: Useful assay for cell-free assessment of degrader ability to induce a functional ternary complex and subsequent ubiquitination	Recombinant E1, E2, E3 ligases, ATP, ubiquitin, ubiquitin conjugation reaction buffer, E3 ligase reaction buffer
	**Degradation**	**Automated western blotting**: Widely used assay for detection of degradation and often used for readout of proteasome inhibitor control experiments. Higher throughput can be achieved with automated capillary electrophoresis	Simple Western™ platforms
	**Pharmacological Effect**	**Cell viability and apoptosis assays, DNA damage CometAssay®, antibody arrays, *in situ* hybridization**: Useful assays to quantify the downstream effects of target degradation in both cells and tissues	Cell Counting Kit-8 / MTT assay, CometAssay®, Proteome Profiler™, RNAscope™

FIGURE 6: Assay workflow for Degrader development.

Featured Product: CoraFluor™ TR-FRET Reagents

CoraFluor™ 1 (Cat. No. 7920) and CoraFluor™ 2 (Cat. No. 7950) are terbium-based TR-FRET donors that emit wavelengths compatible with commonly used fluorescent acceptor dyes such as FAM or FITC, BODIPY® (BDY), Janelia Fluor® dyes, TMR, and Cyanine 5, making it easy to incorporate into ongoing Degrader screening assays.

Compared to existing TR-FRET donors, the CoraFluor fluorescence is brighter and more stable in biological media, enhancing sensitivity and data generation from biochemical assays.

CoraFluor™ 1 exhibits excitation upon exposure to a 337 nm UV laser, whereas CoraFluor™ 2 is cell permeable and displays a red-shifted excitation wavelength, enhancing excitation efficiency at 365 nm and 405 nm. These attributes of CoraFluor™ 2 enable live cell assays to be carried out on a wide range of analytical instruments.

CoraFluor™ reagents can be conjugated directly to your antibody or protein of interest. Alternatively, custom services for the conjugation of CoraFluor reagents to an antibody of your choice are available from R&D Systems.

Target Engagement and Ternary Complex Formation

TR-FRET and FP assays are particularly useful for measuring the binding affinity of small molecules, such as inhibitors and Degraders, to protein targets in a multi-well plate format, allowing for efficient high-throughput screening of target engagement.

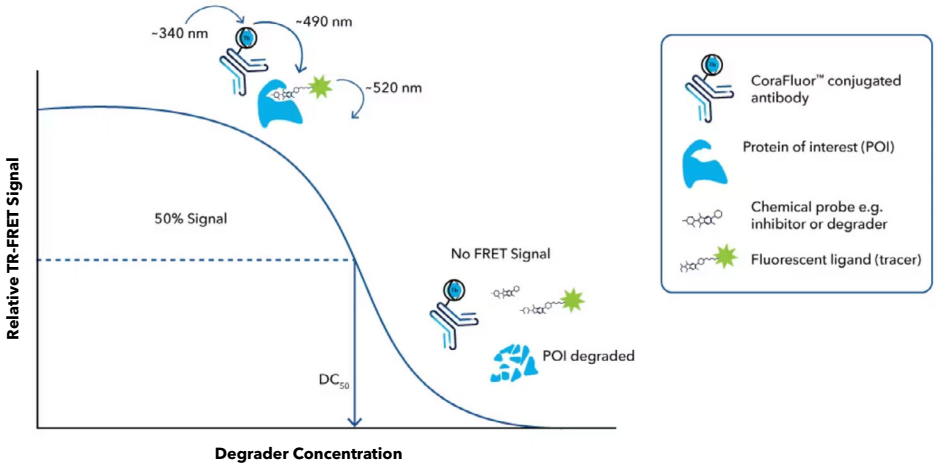


FIGURE 7: CoraFluor™ TR-FRET target engagement assay.

TR-FRET ternary complex assays are valuable in the development of small molecule protein Degraders as they provide a quantitative measure of the interactions between the Degrader, the target protein, and the ubiquitin E3 ligase. CoraFluor™ reagents can be conjugated to antibodies and proteins in a modular fashion to develop high performance TR-FRET assays.

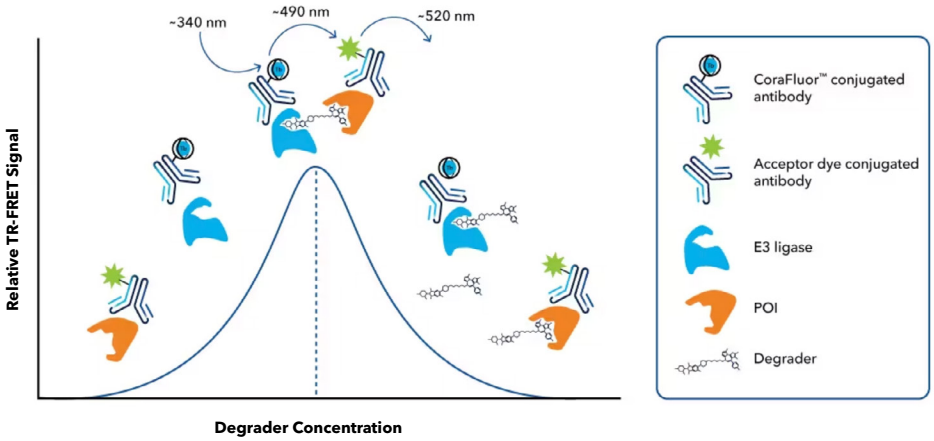


FIGURE 8: CoraFluor™ TR-FRET ternary complex assay.

TR-FRET Donors

7920 - CoraFluor™ 1, amine reactive
7950 - CoraFluor™ 2, amine reactive

E3 Ligase TR-FRET Tracers

Cereblon
7633 - BDY FL Thalidomide
7288 - Thalidomide Cyanine 5
7857 - BDY Lenalidomide

VHL
7483 - BDY FL VH032
7287 - FAM-DEALA-Hyp-YIPD
7452 - FAM-DEALAHypYIPMDDDFQLRSF

IAP
8069 - XIAP Tracer mF-Smac

Keap1
7627 - FITC-labelled Keap1-Nrf2 probe

FEM1C
8043 - FEM1C Tracer ES148

CHIP / STUB1
8045 - FITC-CHIPOpt

POI TR-FRET tracers

Pan BET Bromodomain
7722 - JQ1-FITC

HDAC
7970 - SAHA-FITC

PARP
6461 - PARPi-FL

Pan Kinase
7984 - BDY FL Staurosporine

FIGURE 9: TR-FRET donors and tracers

Simple Western™ Gel-Free, Blot-Free, Hands-Free Western Blots

The efficacy of Degrader molecules is generally characterized by generating dose-response curves using traditional SDS-PAGE Western blotting methods. This manual technique is lengthy and often has poor reproducibility, making it an unreliable approach for the determination of DC_{50} and D_{max} values. In contrast, Simple Western™ instruments from Bio-Techne brand ProteinSimple automate the entire protein separation and detection process, enabling you to separate and analyze proteins by size (or charge) from 2 kDa to 440 kDa. You can analyze up to 25 samples in just 3 hours or up to 96 samples overnight. You'll get quantitative results, reproducibility that's spot on, and use less sample in the process.

Simple Western systems are open platforms, meaning the possibilities are almost endless when selecting antibodies to develop your TPD assays. The Simple Western Antibody Database contains thousands of antibodies validated for Simple Western. Our antibody database is curated to facilitate the selection process by providing general assay development guidance for identifying and selecting antibodies to test, saving you time with recommended starting points to optimize your TPD assays. You may also validate a new antibody and receive a free Separation or Detection Module to run your TPD assays on Simple Western. Learn more about our Antibody Validation Promotion.

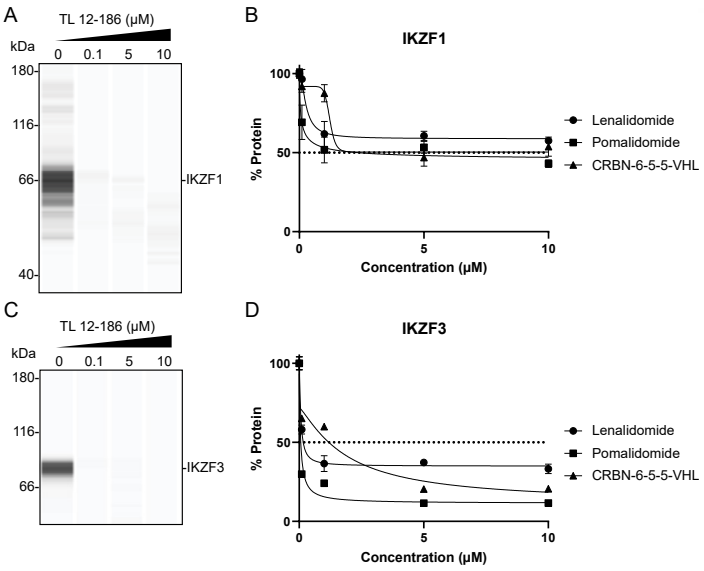


FIGURE 10: Simple Western data showing degradation of IKZF1 and IKZF3 by IMiDs and Degraders in RPMI 8266 cells. **(A)** Lane view of IKZF1 degradation by TL 12-186. **(B)** Percent IKZF1 degradation by concentration of degrader or IMiD. The dotted line represents the 50% degradation threshold used to calculate the DC_{50} values. **(C)** Lane view of IKZF3 degradation by TL 12-186. **(D)** Percent IKZF3 degradation by concentration of Degrader or IMiD. The dotted line represents the 50% degradation threshold used to calculate the DC_{50} values. Experiments were performed by the Simple Western applications science team.

Jess™

- Size-based automated capillary Western blot assays
- Up to 25 samples per run
- Includes RePlex™ and Stellar™
- Chemiluminescence and fluorescence detection

Abby™

- Size-based automated capillary Western blot assays
- Up to 25 samples per run
- Includes RePlex™
- Chemiluminescence detection

Sally Sue™

- Size-based automated capillary Western blot assays
- Up to 96 samples per run
- Chemiluminescence detection

Peggy Sue™

- Size and charge-based automated capillary Western blot assays
- Up to 96 samples per run
- Chemiluminescence detection

Jess™

Jess automates the protein separation and immunodetection of traditional Western blotting, eliminating many tedious, error-prone steps. Just load your samples and reagents into the microplate, and Jess separates your proteins by size and precisely manages antibody additions, incubations, washes, and even the detection steps. Come back to fully analyzed results in 3 hours. Also, the new RePlex™ feature enables you to run two immunoassays within the same capillary to get more rich protein characterization data from just one sample.

- Stellar™ NIR / IR detection modules for Jess set the industry standard for Western blotting fluorescence detection sensitivity
- Quantify expressed phosphorylated target and total target levels
- Normalize your data with total protein expression data in the same capillary
- Save time and money on consumables

See How Your Peers Are Using Simple Westerns to Analyze Protein Knockdown by Targeted Protein Degradation

Charnwood Discovery is a UK-based Contract Research Organization involved in preclinical drug discovery. Specializing in custom assay development and applying new technological approaches to solve their clients' project needs, the company has recently been running screening studies for PROTAC Degraders. Western blot analysis is the standard method for measuring protein levels and Degrader activity. Using traditional western blot, it was taking the Aurelia team 24 to 48 hours to get results. To improve their protein assays for drug discovery, the company now uses Simple Western on Jess. With Jess, the assay throughput time is faster, with the preparation time being 2-3x quicker than by traditional western blot and results are available in around 3 hours. In addition, Simple Western results are clear and easy to interpret.

Rachel Doidge Ph.D., Senior Research Scientist, Charnwood Discovery, Biocity, Nottingham, UK

"I work for a fast-paced drug discovery CRO where our clients expect high-quality data with rapid turnarounds. Jess allows me to accurately assess drug compound potency, and with its high throughput ability I can screen multiple compounds quickly and efficiently."

For more information on how Simple Westerns are being used in targeted protein degradation | bio-techne.com/resources/instrument-applications

In vitro Ubiquitination Assay

Bio-Techne is the leading global provider of Ubiquitin Proteasome System (UPS)-related research products. Our superior quality proteins enable construction of assays to investigate *in vitro* ubiquitination of substrate proteins. This is a powerful approach to evaluate whether a target protein is ubiquitinated in the presence of a Degrader molecule and is amenable to both supplemented cell lysates and fully defined recombinant reactions.

These assays provide a useful metric for Degrader discovery programs, without complicating factors such as Degrader cellular permeability and efflux.

In the example below, a functional CRBN E3 ligase complex (Cat. No. E3-650) was used to investigate *in vitro* polyubiquitination of recombinant FLAG-tagged BRD4 (Cat. No. SP-600). Results were analyzed using an anti-FLAG Western Blot.

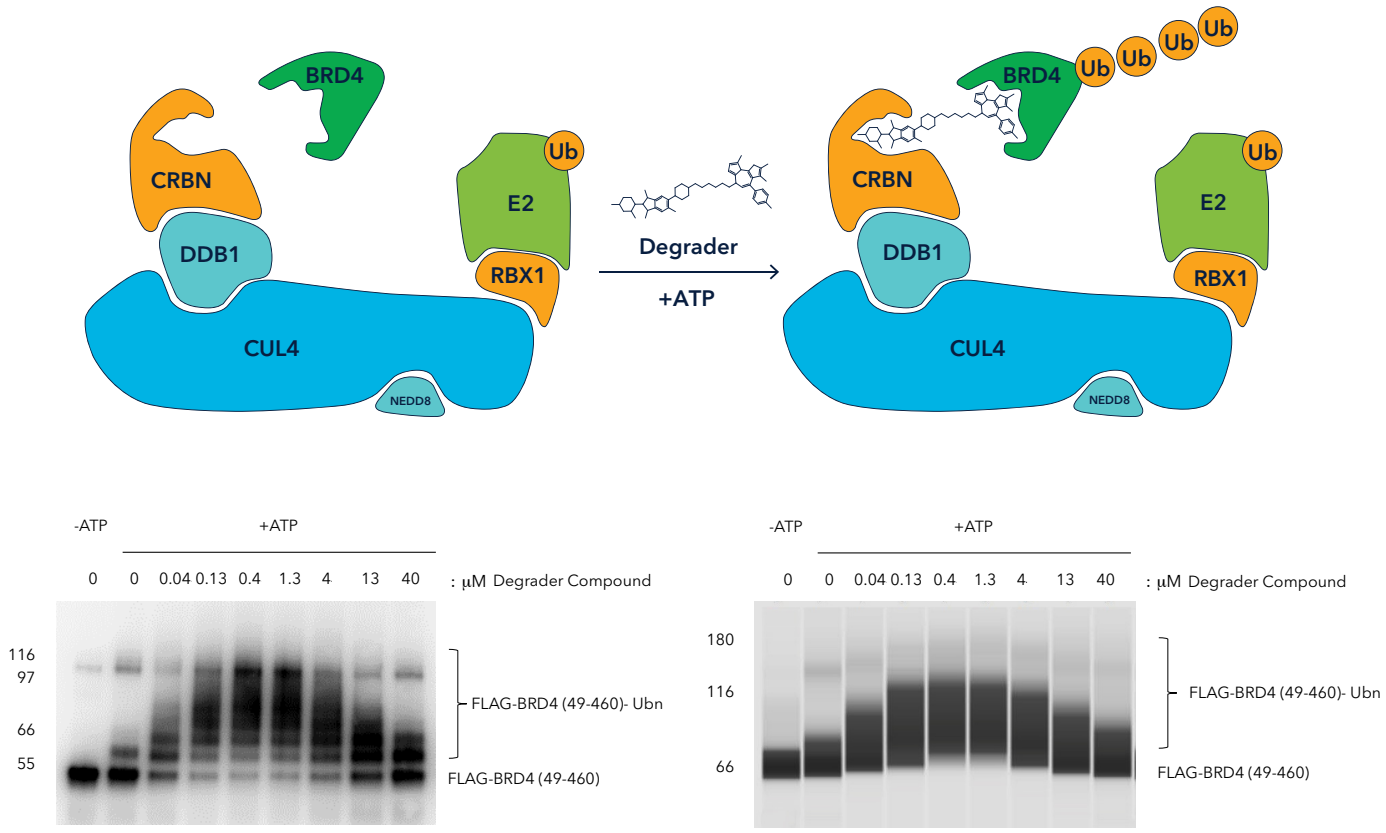


FIGURE 11: Western blot data (left panel) and Simple Western data (right panel) showing Degrader-dependent polyubiquitination of recombinant BRD4. The degree of substrate ubiquitination varies with the concentration of Degrader used in the reaction, and the so-called "hook effect" is clearly evident.

Assay Component	Product Name	Catalog #
ATP	ATP Disodium Salt	3245
BRD4 Substrate	Human His10-FLAG-BRD4 (49-460)	SP-600
Degrader	AKE-212	-
E1 enzyme	Human UBE1	E-304
E2 enzyme	Human UBE2D1	E2-616
E3 Ligase Complex	Human CUL4/RBX1/DDB1/CRBN	E3-650
Ubiquitin	Human Ubiquitin	U-100H

How Has This Degrader Affected My Cells?

Exploring the resulting phenotype following successful Degrader-mediated protein degradation enables an understanding of the biological role of the POI.
A relevant question to ask is: "does degradation offer a more desirable or differentiated phenotype compared to inhibition?" Our downstream pharmacology assays provide researchers with methods to explore and understand the biological consequences of targeted protein degradation.

Bio-Techne offer a variety of assays to profile the downstream cellular response upon treatment with a Degrader.

Cell Viability and Proliferation Assays

Assessing cell viability and proliferation of a cell population upon treatment with a Degrader can be used to evaluate the toxicity or effectiveness of a series of candidate Degraders.

Featured Product: Cell Counting Kit-8

Cat. No. 7368

Ready-to-use solution for high throughput cell viability and proliferation assays

Product Name	Catalog #
TACS MTT Cell Proliferation Assay	4890-050-K
TACS XTT Cell Proliferation Assay	4891-025-K
Resazurin	AR002
Calcein AM	4892-010-01

Apoptosis Assays

Measuring apoptosis using our Annexin V-FITC Apoptosis Detection Kit after treatment with a PROTAC is essential to assess the therapeutic efficacy, safety, and mechanism of action. By detecting apoptotic cells, it is possible to quantify the extent of cell death induced by PROTAC-mediated targeted protein degradation. This information helps optimize treatment conditions, differentiate apoptosis from necrosis, and identify potential off-target effects, ensuring a comprehensive understanding of the product's impact on targeted cells. The Annexin V-FITC Apoptosis Detection Kit serves as a reliable tool for evaluating PROTAC performance and guiding their successful development for clinical applications.

DNA Damage CometAssay

Targeting undruggable proteins such as transcription factors is one of the promises of Degraders as new therapeutics. Degradation of targets such as BRD4 has cytotoxic effects and can interfere with transcription, resulting in DNA damage. Bio-Techne offer a CometAssay Single Cell Gel Electrophoresis Assay able to characterise and quantify DNA double strand breaks following Degrader treatment, demonstrated in **FIGURE 12** by treatment of HeLa cells with dBET6.

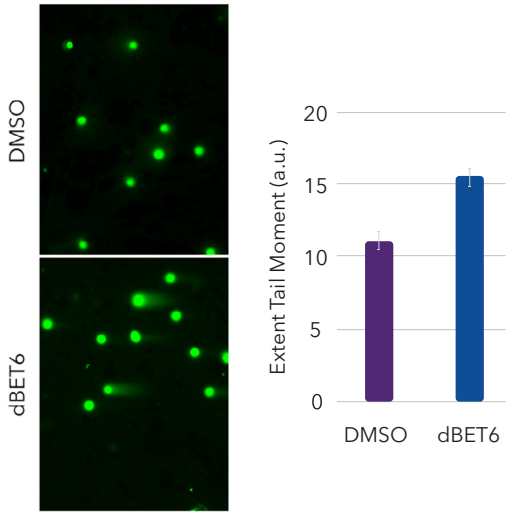
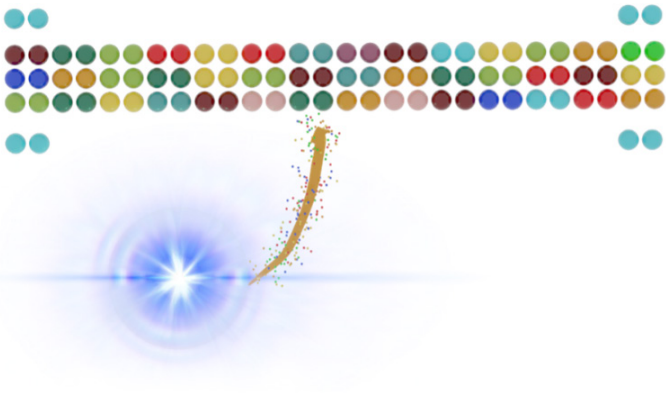


FIGURE 12: Single cell electrophoresis CometAssay to measure DNA double strand breaks after dBET6 treatment in HeLa Cells (6 hr dBET6 treatment at 10 nM).

Data provided by the Floyd Lab, Duke University

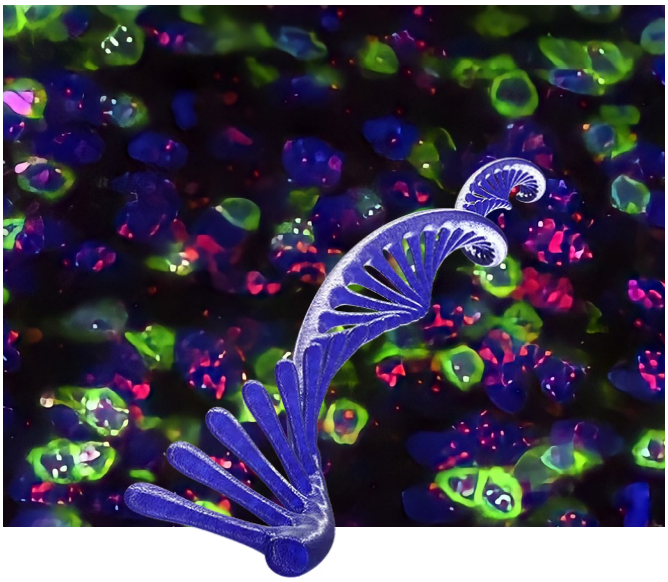
Proteome Profiler

Proteome Profiler Antibody Arrays are a simple, high throughput and cost-effective tool for early-stage analyte profiling and screening of up to 100 analytes in a single sample. Our antibody arrays have superior specificity, low background noise and no cross-reactivity, meaning that you can count on this assay for clear and consistent data. Use our antibody arrays as part of your PROTAC® assay cascade to explore the downstream consequences of Degrader-induced protein knockdown.



In Situ Hybridization with RNAscope™

RNAscope *in situ* hybridization technology is a powerful tool that allows you to spatially map and quantify specific target mRNAs in intact cells and tissues. Detect up to 12 RNA targets simultaneously using the RNAscope HiPlex assay or combine the assay with IHC or IF on the same slide to investigate mRNA and protein co-expression. Catalog probes are available for over 23,000 targets in 140+ species including POIs, E3 ligases and downstream targets, and can also be made-to-order. Discover how your Degrader affects downstream gene expression or broadly profile gene expression across tissues to support development of tissue selective Degraders using RNAscope.



Ubiquitin Proteasome System Proteins

E3 Ligase Enzymes

Bio-Techne's Ubiquitin Proteasome Group, formerly Boston Biochem, provides superior quality UPS proteins such as E3 ligase enzymes and offers custom manufacture of proteins not currently available in our catalog. For more information visit https://www.bio-techne.com/services/custom-protein-services.

Many E3 ligase enzymes assemble into multi-subunit complexes using, in the case of the Cullin-RING type E3 ligases, a repertoire of substrate receptors e.g. Cereblon (CRBN), adapters (e.g. DDB1), Cullin scaffolds (e.g. CUL4A) and RING proteins (e.g. RBX1).

Product Name	Catalog #
CUL1/RBX1	E3-410
CUL2/RBX1	E3-420
CUL3/RBX2	E3-430
CUL3/RBX1	E3-435
CUL4A/RBX1	E3-440
DDB1/CRBN	E3-500
CUL4A/RBX1/DDB1/CRBN	E3-650
ELOB/ELOC/VHL	E3-600
CUL2/RBX1/ELOB/ELOC/VHL	E3-655

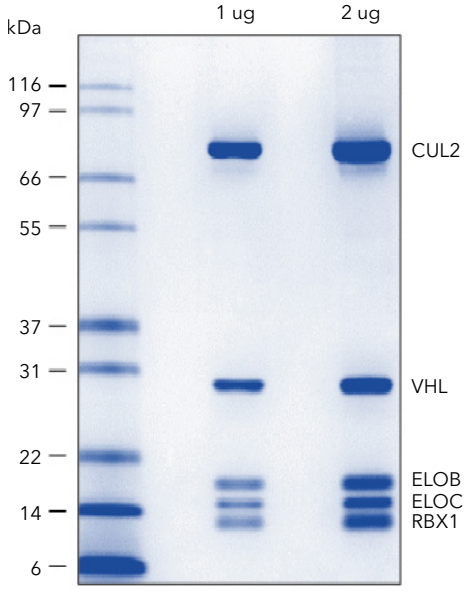


FIGURE 13: SDS-PAGE gel stained with colloidal Coomassie blue with 1 µg and 2 µg loading of CUL2/ RBX1/ELOB/ ELOC/VHL (Cat. No. E3-655)

Neddylated Cullin/ RBX Complexes

Covalent attachment of Nedd8 protein to Cullins (neddylation) leads to activation of Cullin-RING ligases *in vivo*. Neddylation regulates many biological processes, including cell cycle progression, signal transduction, and alterations in the normal neddylation process have been implicated in the development of disease states including tumorigenesis. While neddylation of cullin subunits is often dispensable for *in vitro* ubiquitination reactions, there are instances in which a neddylated cullin complex may be desirable. Our neddylated Cullin/ RBX complexes may be directly substituted for their non-neddylated counterparts.

Product Name	Catalog #
CUL1(NEDD8)/RBX1	E3-411
CUL2(NEDD8)/RBX1	E3-421
CUL3(NEDD8)/RBX2	E3-431
CUL3(NEDD8)/RBX1	E3-436
CUL4(NEDD8)/RBX1	E3-441
CUL5(NEDD8)/RBX2	E3-451

Where Science Intersects Innovation™

Bio-Techne® | R&D Systems™ Novus Biologicals™ Tocris Bioscience™ ProteinSimple™ ACD™ ExosomeDx™ Asuragen®

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