Supporting information

Set of small molecule polyurethane (PU) model substrates: Ecotoxicity evaluation and identification of PU degrading biocatalysts

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1. Chemical Methods

Solvents and Reagents

Solvents for dry-flash chromatography and MS analysis, as well as commercial materials and other solvents were purchased at the highest commercial quality from the providers Acros Organics, Alfa Aesar, Merck, Sigma Aldrich, and Thermo Fisher Scientific, in a purity of over 99% (HPLC-grade).

Chromatography

Thin-layer chromatography (TLC) was performed on precoated plates of silica gel F254 (Merck) with UV detection at 254 and 365 nm. Column chromatography was performed on silica gel Silica 10e18, 60 Å, ICN Biomedicals.

HR-MS

For high resolution mass spectrometry mass spectra were obtained on MS LTQ Orbitrap XL with heated ESI ionization (HESI).

NMR

^{1}H and ^{13}C Nuclear Magnetic Resonance Spectra (NMR) were recorded on Varian/Agilent NMR 400 MHz (^{1}H at 400 MHz, ^{13}C at 100 MHz). Chemical shifts (δ) are expressed in ppm and coupling constant (J) in Hz. TMS was used as an internal standard. The following abbreviation were used for signal multiplicities (s as singlet, t as triplet, q as quartet, dd as doublet of doublets, tt as triplet of triplets, m as multiplet).

Synthetic details

2-hydroxyethyl phenyl-carbamate **(PU-1):** Benzyloxy ethanol (2 eq) was added drop-wisely to the solution of phenyl isocyanate (1 eq) and ethyl-acetate (10 ml) and reflux overnight at 77°C. The next day, the reaction was stopped and extracted with ethyl-acetate and water. The organic layer was washed with sodium bicarbonate and Brine solution. The final product was purified by dry-flash chromatography using PE/EA=8:2, 7:3 eluents. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34-7.29 (m, ^{9}H), 7.05 (t, ^{1}H), 6.76 (s, ^{1}H), 4.57 (s, ^{2}H), 4.34 (t, ^{2}H), 3.70 (t, ^{2}H). **^{13}C NMR** (400 MHz, $CDCl_3$) δ 153.32, 137.75, 129.01, 128.44, 127.79, 123.45, 73.20, 68.21, 64.24 and used further as a substrate in process of overnight hydrogenolysis in dichloromethane solution and a quantitative amount of Pd/C as a catalysator at room temperature. After overnight reaction the reaction mixture was filtered and pure by dry-flash chromatography (PE/EA=6:4) It was obtained 460 mg (77%) of the final product like a light-yellow oil. **^{1}H NMR** (400 MHz, $CDCl^{3}$) δ 7.34-7.28 (m, 4H), 7.05 (t, 1H), 6.91 (s, ^{1}H), 4.29 (t, 2H), 3.85 (t, 2H), 2.26 (s, 1H). **^{13}C NMR** (400 MHz, $CDCl_3$) δ 153.78, 137.56, 129.03, 123.67, 118.78, 66.83, 61.53.

2-ethoxyethyl phenylcarbamate **(PU-2):** Ethylene glycol-monoethyl ether (2 eq) was added drop-wisely to the solution of phenyl isocyanate (1 eq) and ethyl-acetate (6 ml) and reflux at 77 °C. The reaction was followed by TLC (PE/EA=7:3) and stopped after 3h. The extraction was done with ethyl-acetate and water. The organic layer was washed with sodium bicarbonate and Brine solution and the final product was purified by dry-flash chromatography using PE/EA=8:2, 7:3 eluents. The pure product was obtained like yellow oil, 487, 7 mg (60 %). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34-7.27 (m, 4H), 7.03 (t, 1H), 6.79 (s, 1H), 4.29 (t, 2H), 3.66 (t, 2H), 3.53 (q, 2H), 1.21 (t, 3H). **^{13}C NMR** (400 MHz, $CDCl_3$) δ 153.33, 137.80, 128.99, 123.39, 118.60, 68.60, 66.61, 64.30, 15.07.

HR-MS(HESI+) *m/z* calculated for $C_{11}H_{15}NO_3$ $[M+H]^+$: 210.11247, found: 210.11217, and $[M+Na]^+$: 232.09441, found: 232.09434.

Ethane-1,2-diyl bis(phenylcarbamate) **(PU-3):** Ethylene glycol (4.3 g, 3.9 ml, 0.07 mol) was dissolved in 30 ml of dried EtOAc and added drop wisely to the solution of phenyl isocyanate (17.5 ml, 0.14 mol) in EtOAc (20 ml). The reaction mixture was heated to reflux overnight. After cooling down the mixture, the product crystallized from the reaction mixture along with the impurities. After several recrystallizations from hot ethyl acetate (2 ml/1g) the pure product was obtained as white crystals 15 g (71 %). **^{1}H NMR** (400 MHz, DMSO-d6) δ 9.70 (s, 2H), 7.42 (t, J = 6.9 Hz, 4H), 7.24 (t, J = 7.7 Hz, 4H), 6.96 (t, J = 7.5 Hz, 2H), 4.30 (s, 4H). **^{13}C NMR** (100 MHz, DMSO-d6) δ 153.8, 139.4, 129.2, 122.9, 118.6, 63.1. **HR-MS**(HESI+) *m/z* calculated for $C_{16}H_{16}N_2O_4$ $[M+Na]^+$: 323.10023, found: 323.10016.

2-((phenylcarbamoyl)oxy)ethyl hexanoate **(PU-4):** 2-hydroxyethyl phenylcarbamate was dissolved in dichloromethane (2 ml) and a solution of pyridine (1.5 eq) in dichloromethane (2 ml) was added to the carbamate, followed by the addition of a solution of hexanoyl chloride (1 eq) in dichloromethane (2 ml). The reaction was stirred at room temperature for 4h and followed by TLC (PE/EA=6:4). The extraction was done with ethyl-acetate and water, and the organic layer was washed with sodium bicarbonate and Brine solution. The pure product was obtained after dry-flash chromatography (PE/EA=7:3) like a yellow oil, 86%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35-7.29 (m, 4H), 7.05 (t, 1H), 6.68 (s, 1H), 4.34-4.32 (dd, 4H), 2.32 (t, 2H), 1.62 (t, 2H), 1.28 (m, 4H), 0.86 (t, 3H). **^{13}C NMR** (400 MHz, CDCl3) δ 173.61, 152.98, 137.57, 129.04, 123.59, 118.64, 63.01, 62.16, 34.08, 31.23, 24.52, 22.25, 13.86. **HR-MS**(HESI+) *m/z* calculated for $C_{15}H_{21}NO_4$ $[M+Na]^+$: 302.13628, found: 302.13694.

Bis(2-((phenylcarbamoyl)oxy)ethyl) adipate **(PU-5):** 2-hydroxyethyl phenyl carbamate was dissolved in dichloromethane (2 ml) and a solution of pyridine (1.5 eq) in dichloromethane (2 ml) was added to the carbamate, followed by the addition of a solution of adipic-dichloride (1 eq) in dichloromethane (2 ml). The reaction was stirred at room temperature overnight and followed by TLC (PE/EA=6:4). The extraction was done with ethyl-acetate and water, and the organic layer was washed with sodium bicarbonate and Brine solution. The pure product was obtained after dry-flash chromatography (PE/EA=7:3, 6:4) like a colorless oil that crystallizes after fridge storage, 86%. ^{1}**H NMR** (400 MHz, CD_3OD) δ 7.37-7.27 (m, 8H), 7.04 (t, 3H), 5.27 (s, 1H), 4.32 (q, 8H), 2.35 (t, 4H), 1.68 (m, 4H). ^{13}**C NMR** (400 MHz, CD3OD) δ 173.27, 153.09, 137.76, 128.98, 123.50, 118.73, 62.77, 62.40, 33.73, 24.23. **HR-MS**(HESI+) *m/z* calculated for $C_{24}H_{27}N_2O_8$ $[M+Na]^+$: 495.17379, found: 495.17570.

Bis(2-hydroxyethyl) (4-methyl-1,3-phenylene)dicarbamate **(PU-6):** Toluene diisocyanate (1 eq) was added drop-wisely to the solution of ethylene glycol (25 eq) and ethyl-acetate (50 ml) under Ar atmosphere, and refluxed overnight at 77°C. The next day, the reaction was stopped, cooled down to room temperature, and extracted with ethyl-acetate and water. The organic layer was washed with sodium bicarbonate and Brine solution. The obtained yellow oil was dissolved in a minimal amount of hot ethyl-acetate and cooled in the fridge overnight to obtained white crystals. The process of recrystallization was repeated 2 times and it was obtained 78 % of pure white crystals. The reaction was followed by TLC=$CHCl_3$/MeOH=9:1. ^{1}**H NMR** (400 MHz, CD_3OD) δ 7.54 (s, 1H), 7.14 (d, 1H), 7.08 (d, 1H), 4.36 (s, 1H), 4.16 (q, 4H), 3.74 (q, 4H), 3.57 (s, 1H), 3.32 (s, 1H), 3.28 (t, 2H), 2.17 (s, 3H). ^{13}**C NMR** (400 MHz, CD_3OD) δ 155.37, 154.54, 137.00, 136.06, 130.13, 115.52, 114.63, 66.20, 65.92, 62.88, 59.97, 15.82. **HR-MS**(HESI+) *m/z* calculated for $C_{13}H_{18}N_2O_6$ $[M+Na]^+$: 321.10571, found: 321.10525.

Bis(2-ethoxyethyl) (4-methyl-1,3-phenylene)dicarbamate **(PU-7):** Toluene diisocyanate (1 eq) was added drop-wisely to the solution of ethylene glycol monoethyl ether (25 eq) and ethyl-acetate (50 ml) under Ar atmosphere, and refluxed overnight at 77°C. The next day, the reaction was stopped, cooled down to room temperature, and extracted with ethyl-acetate and water. The organic layer was washed with sodium bicarbonate and Brine solution and purification was done by dry-flash chromatography (CHCl3/MeOH=95:5, 9:1). The obtained yellow oil was repurified by dry-flash chromatography and it was obtained 50% of the product (90% of purity). ^{1}**H NMR** (400 MHz, CD_3OD) δ 7.79 (s, 1H), 7.16 (s, 1H), 7.08 (d, 1H), 7.05 (d, 1H), 6.72 (s, 1H), 6.50 (s, 1H), 4.29 (m, 4H), 3.66 (m, 4H), 3.52 (m, 4H), 2.16 (s, 3H), 1.20 (m, 6H). ^{13}**C NMR** (400 MHz, CD_3OD) δ 153.45, 153.29, 136.56, 136.19, 130.73, 128.98, 128.17, 125.24, 68.63, 66.61, 64.45, 64.29, 20.74, 17.01, 15.07.

Bis(2-((phenylcarbamoyl)oxy)ethyl) (4-methyl-1,3-phenylene)dicarbamate **(PU-8):** Toluene diisocyanate (13.6 g, 11 ml, 0.1 mol) was dissolved in 25 ml of dried EtOAc and added drop wisely into the solution of ethylene glycol (48 g, 43 ml, 1 mol) in 45 ml of EtOAc. Reaction mixture was heated to reflux overnight. Aduct was obtained by crystallization from hot ethyl-acetate. After several recrystallizations from ethyl acetate, pure product was obtained as white crystals 10 g, 35 % yield. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.55 (s, 1H), 7.15 (d, J = 7.7 Hz, 1H), 7.07 (d, J = 8.3 Hz, 1H), 4.17 (dd, J = 10.2, 5.6 Hz, 4H), 3.75 (dd, J = 9.4, 4.5 Hz, 4H), 2.18 (s, 3H). **^{13}C NMR** (100 MHz, CD_3OD) δ 155.4, 137.0, 136.1, 130.1, 115.5, 114.6, 66.2, 60.0, 15.8. Product from previous step (9.5 g, 0.03 mol) was dissolved in the mixture of solvents 120 ml EtOAc / DMF (1/1) and added drop wisely to the solution of phenyl isocyanate (10.8 ml, 0.1 mol) in ethyl acetate (60 ml) at room temperature, under the inert atmosphere. Reaction mixture was stirred overnight at 60 °C and then thoroughly washed with water (x7). Solvent was evaporated and the crude product was carefully purified by column chromatography (eluant: petroleum ether/EtOAc - 8/2). Final product (4.9 g, 30 %) was obtained in a form of white crystals. **^{1}H NMR** (400 MHz, DMSO-d6) δ 9.69 (s, 2H), 9.63 (s, 1H), 8.90 (s, 1H), 7.49 – 7.39 (m, 5H), 7.24 (t, J = 7.8 Hz, 4H), 7.12 (d, J = 7.9 Hz, 1H), 7.03 (d, J = 8.3 Hz, 1H), 6.96 (t, J = 7.4 Hz, 2H), 4.28 (s, 8H), 2.08 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d6) δ 154.6, 153.8, 153.7, 139.4, 137.4, 136.7, 130.7, 129.2, 123.0, 118.7, 63.2, 63.1, 63.1, 63.0, 17.5. **HR-MS**(HESI+) *m/z* calculated for $C_{27}H_{28}N_4O_8$ $[M+Na]^+$: 559.17993, found: 559.18223.

NMR spectra

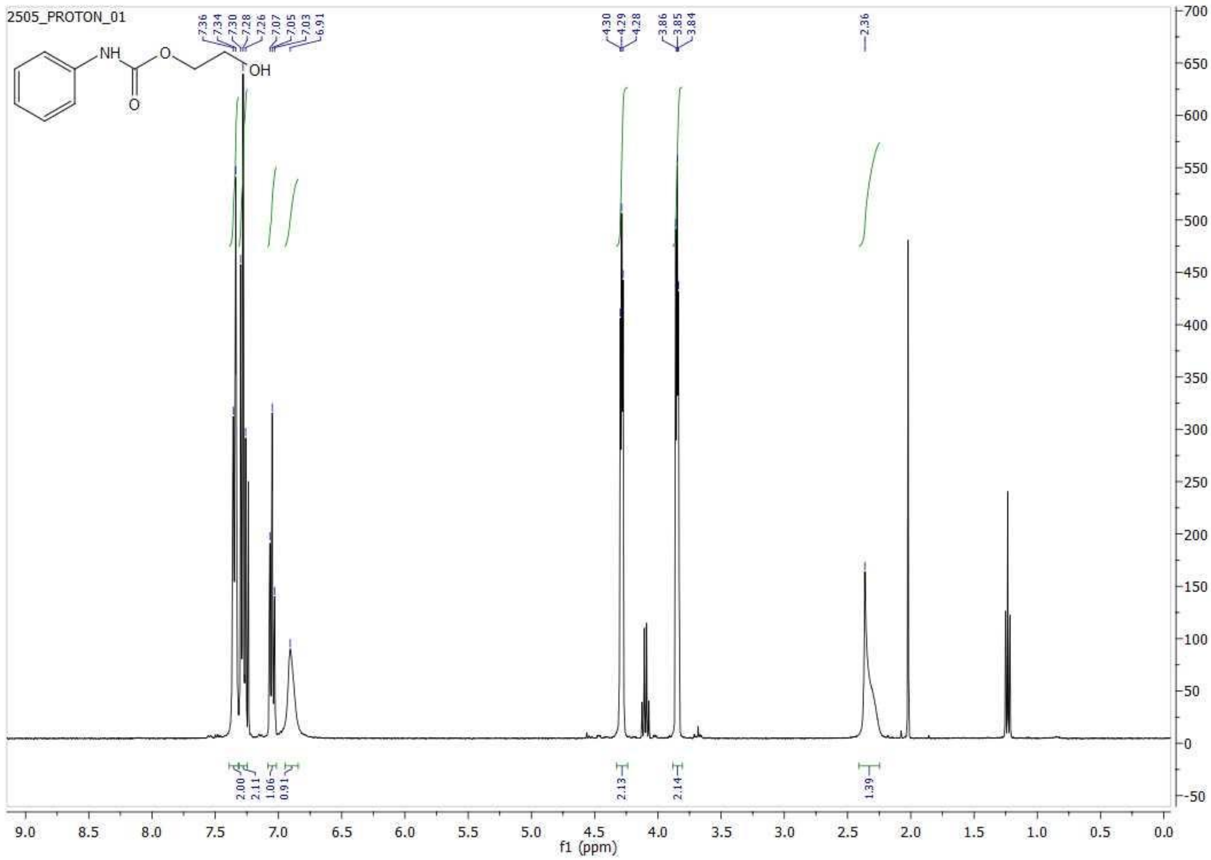

Figure S1.[1]H-NMR spectrum of *2-hydroxyethyl phenyl-carbamate* (**PU-1**)

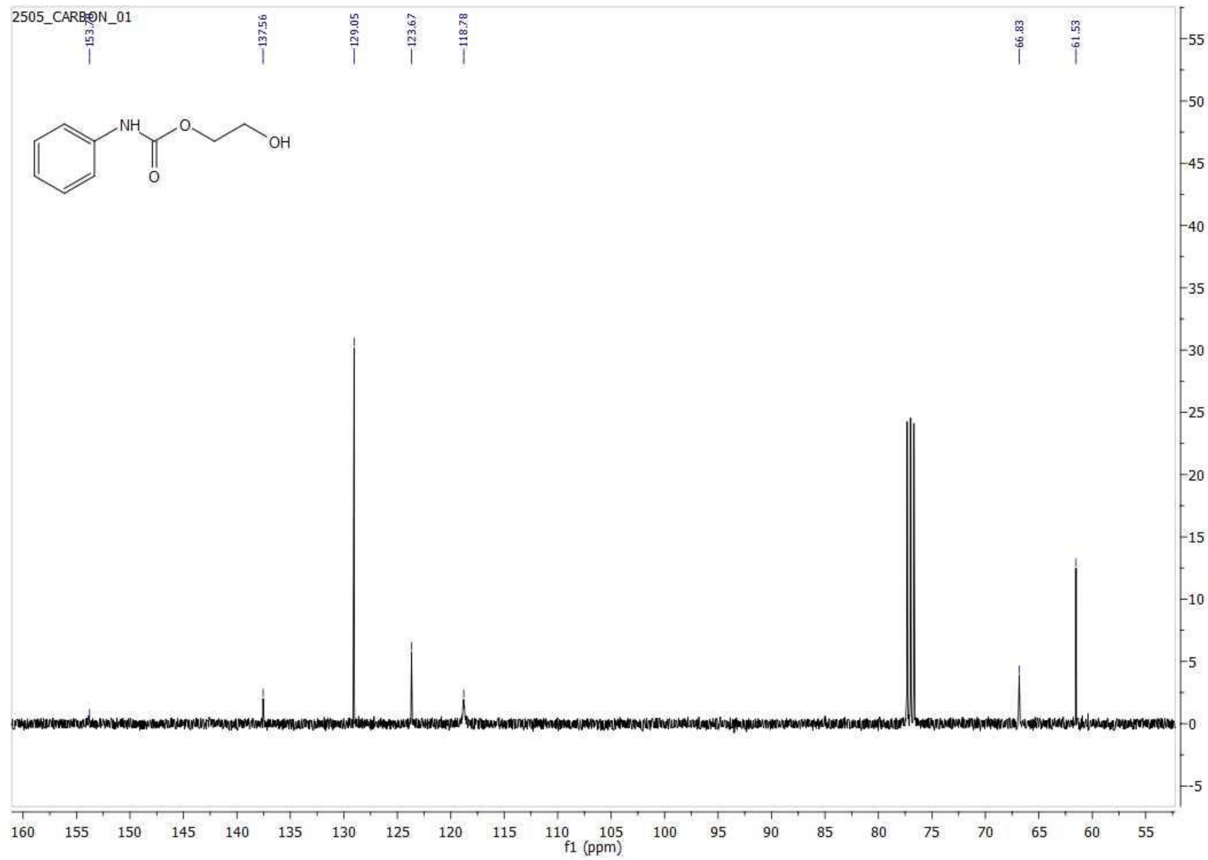

Figure S2.[13]C-NMR spectrum of *2-hydroxyethyl phenyl-carbamate* (**PU-1**)

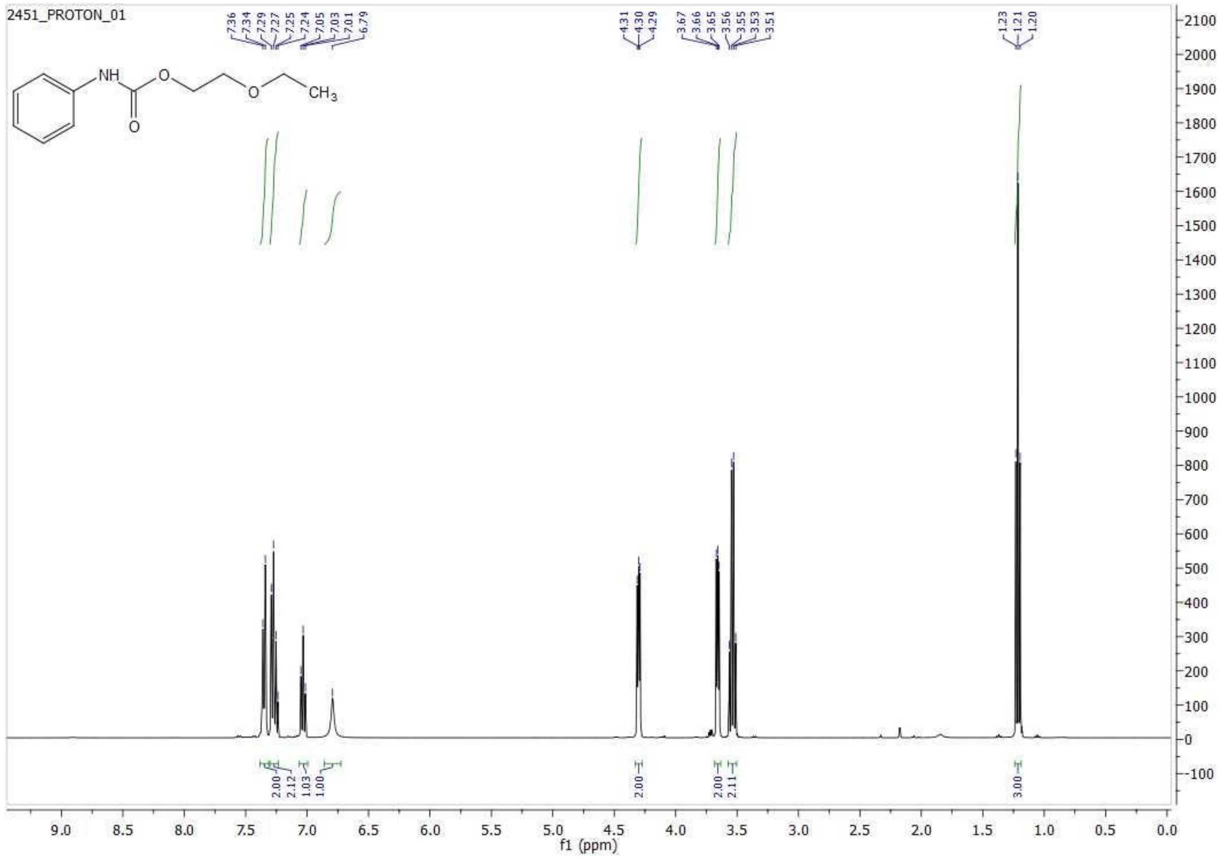

Figure S3.[1]H-NMR spectrum of *2-ethoxyethyl phenylcarbamate* (**PU-2**)

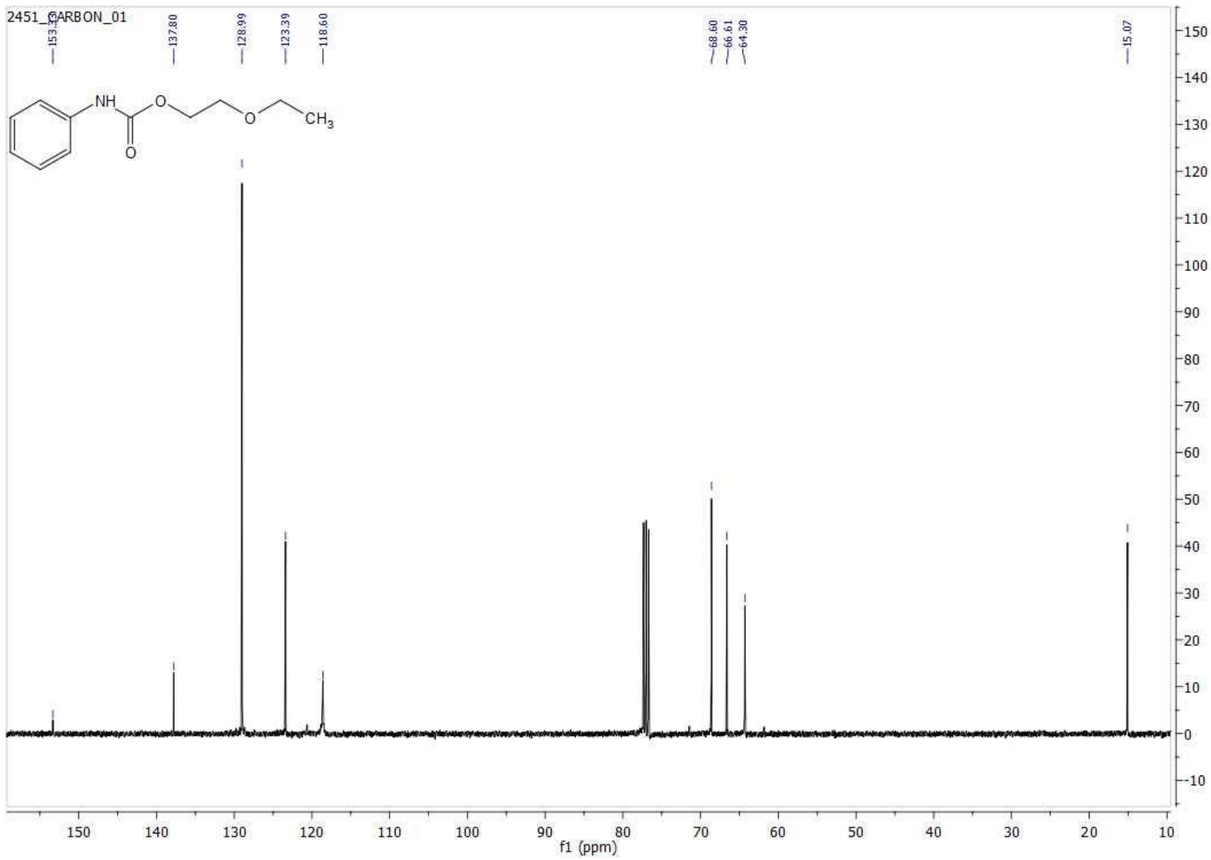

Figure S4.[13]C-NMR spectrum of *2-ethoxyethyl phenylcarbamate* (**PU-2**)

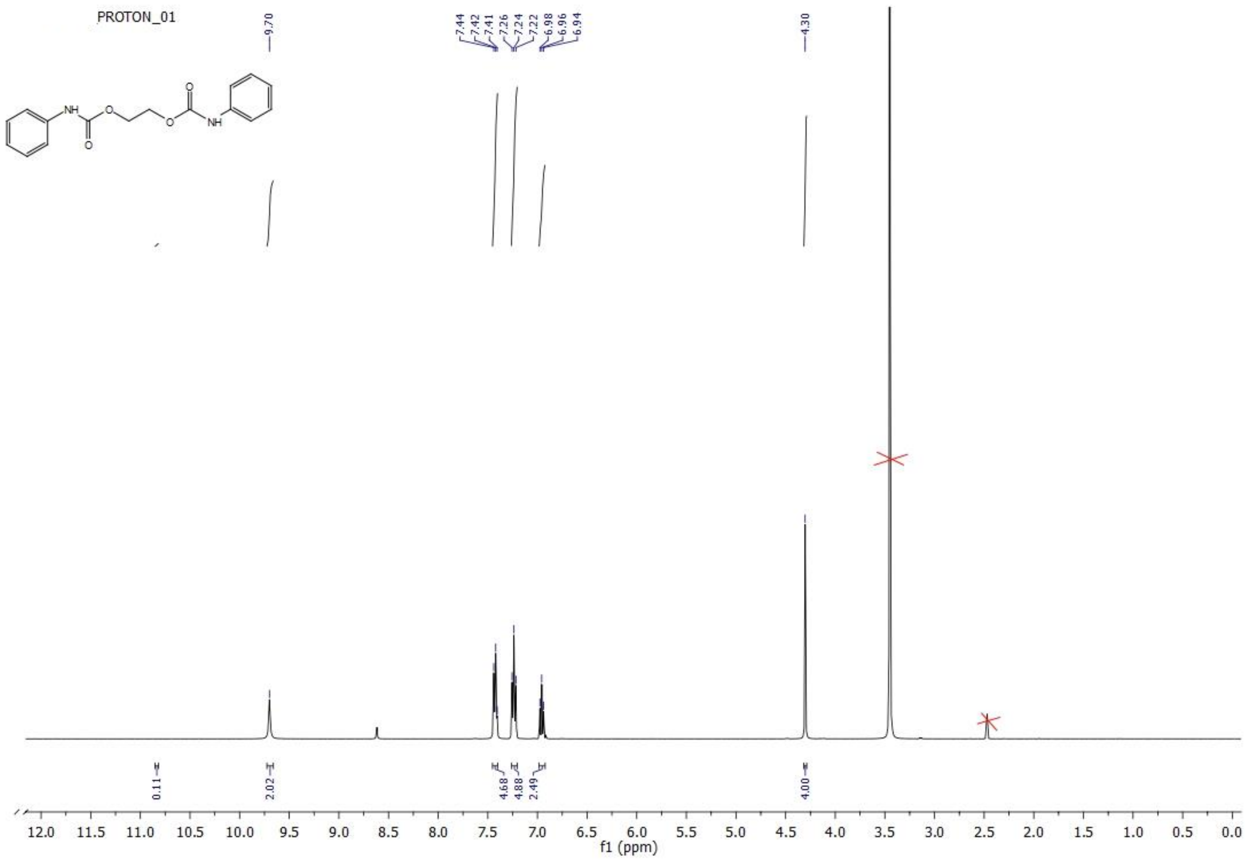

Figure S5. ^{1}H-NMR spectrum of *ethane-1,2-diyl bis(phenylcarbamate)* (**PU-3**)

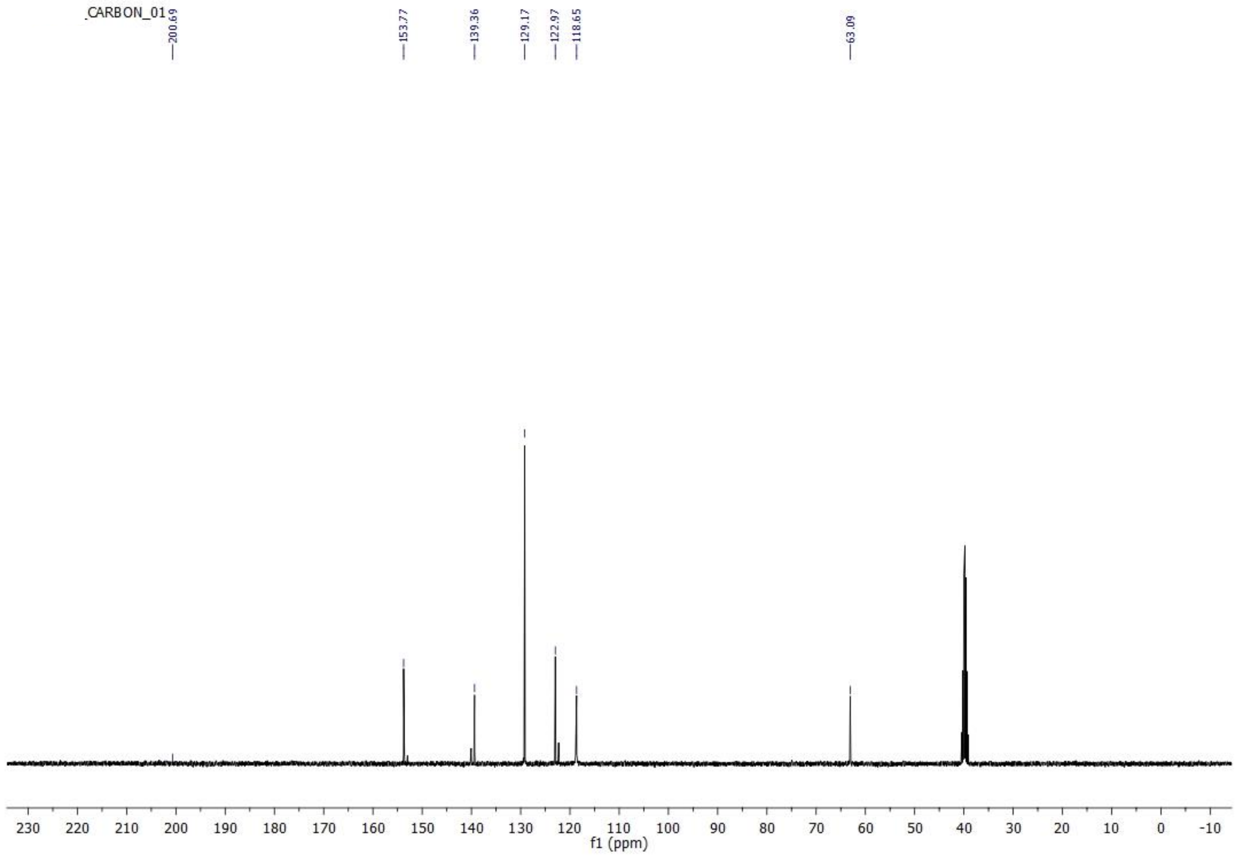

Figure S6. ^{13}C-NMR spectrum of *ethane-1,2-diyl bis(phenylcarbamate)* (**PU-3**)

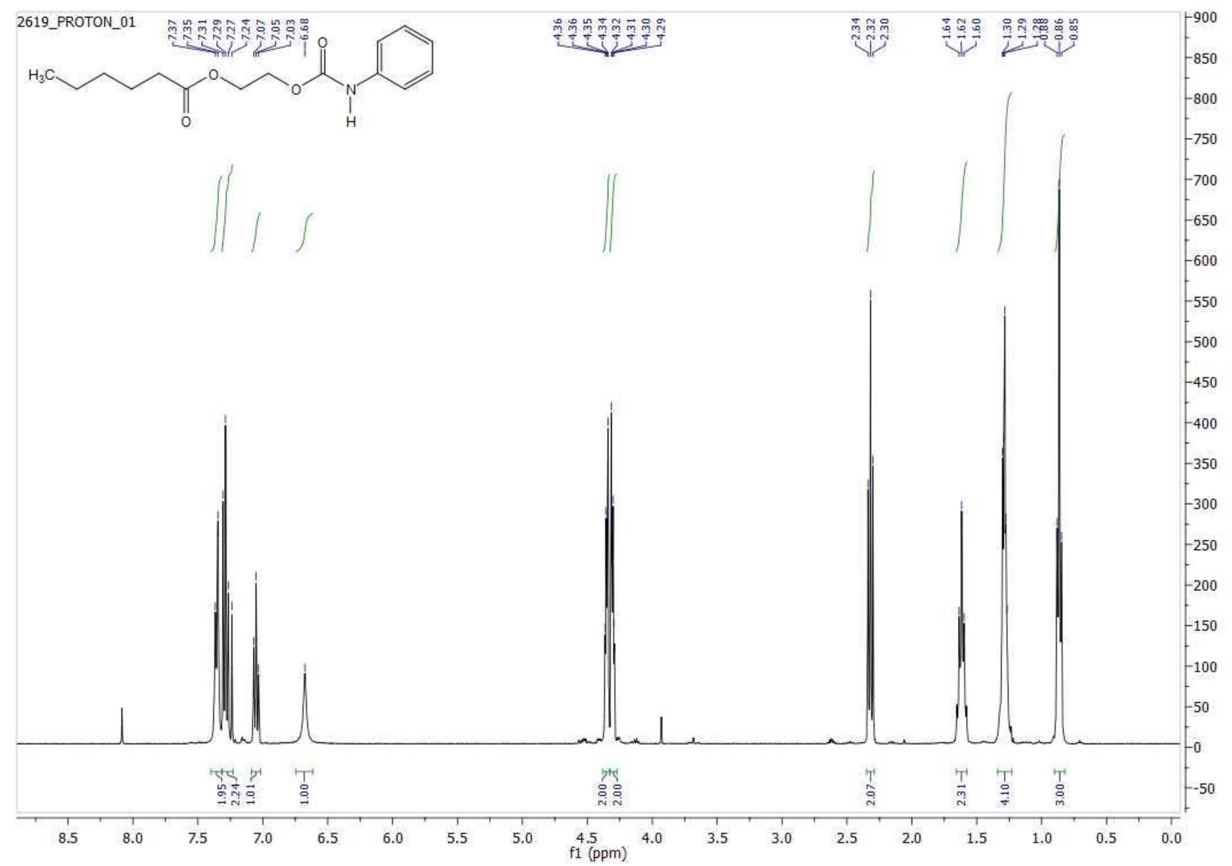

Figure S7.[1]H-NMR spectrum of *2-((phenylcarbamoyl)oxy)ethyl hexanoate* (**PU-4**)

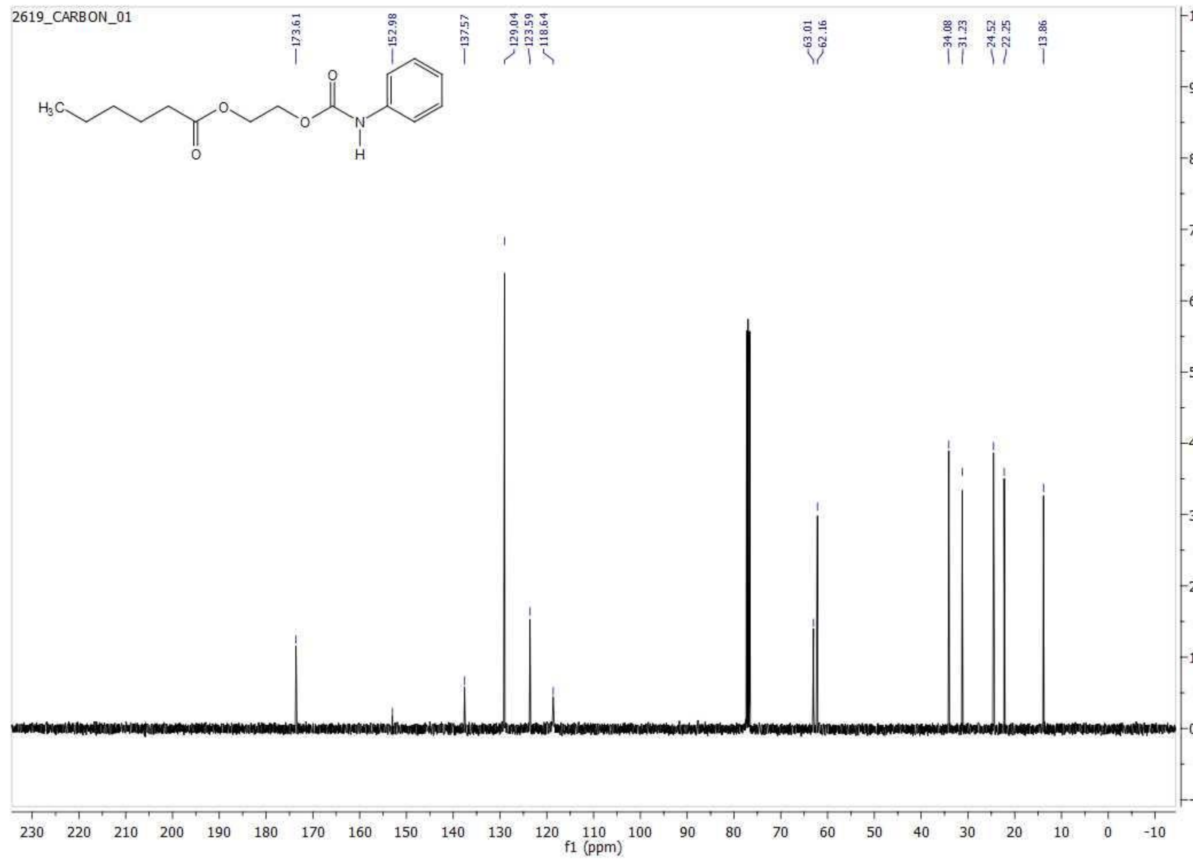

Figure S8.[13]C-NMR spectrum of *2-((phenylcarbamoyl)oxy)ethyl hexanoate* (**PU-4**)

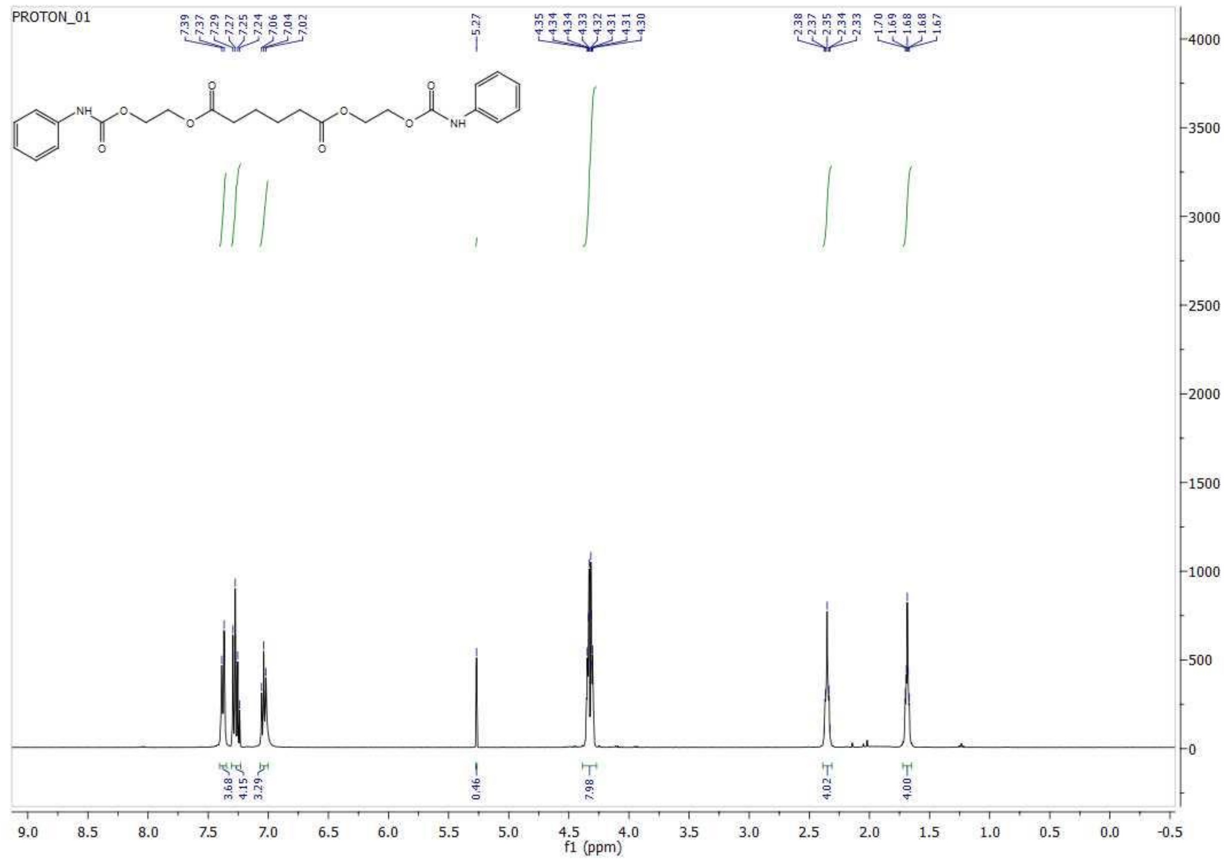

Figure S9. ^{1}H-NMR spectrum of *bis(2-((phenylcarbamoyl)oxy)ethyl) adipate* (**PU-5**)

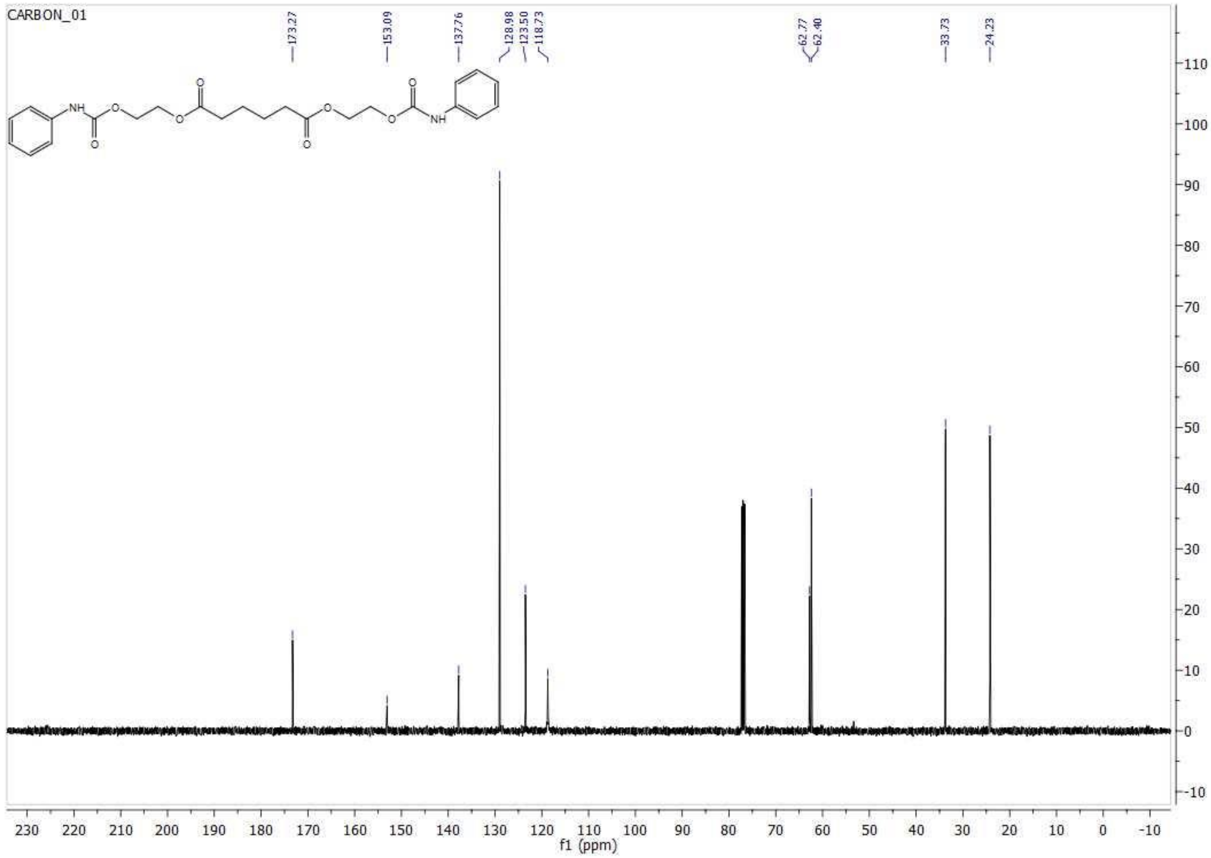

Figure S10.[13]C-NMR spectrum of *bis(2-((phenylcarbamoyl)oxy)ethyl) adipate* (**PU-5**)

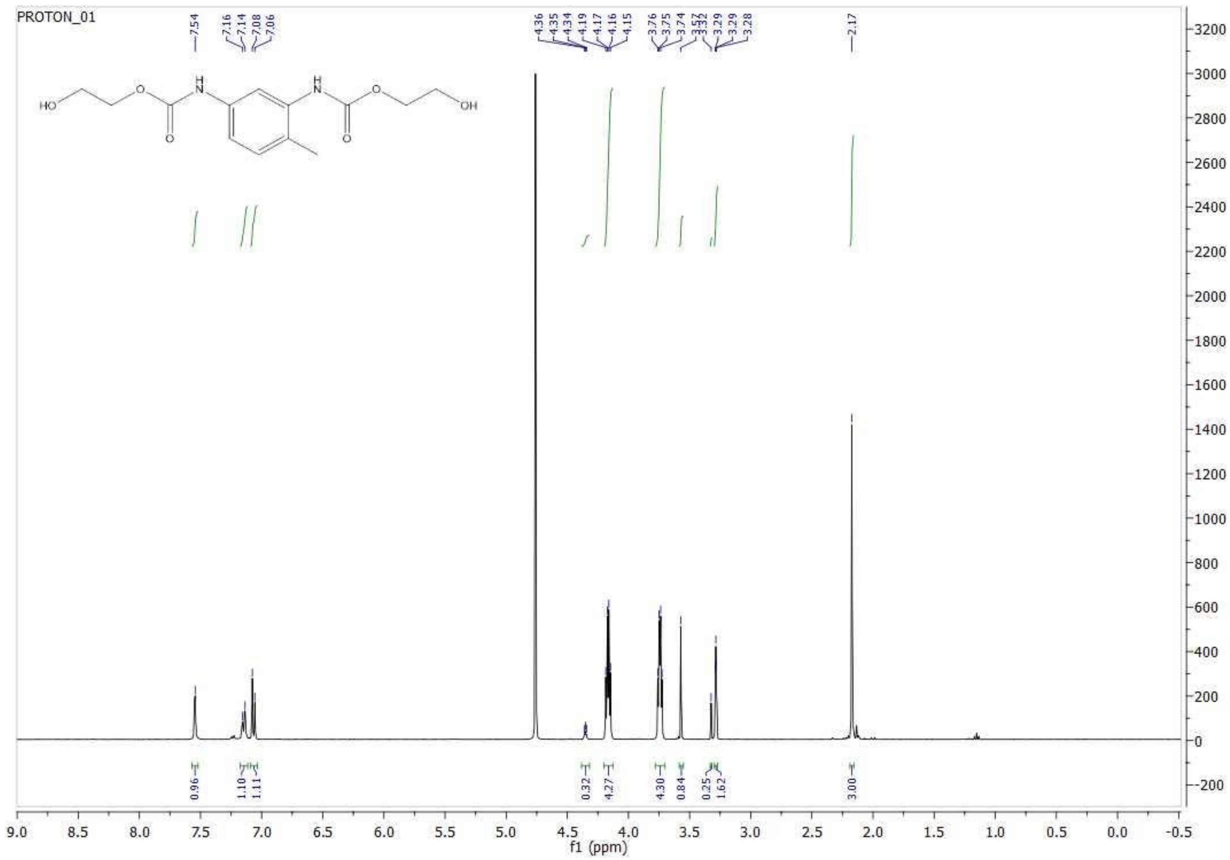

Figure S11.[1]H-NMR spectrum of *bis(2-hydroxyethyl) (4-methyl-1,3-phenylene)dicarbamate* (**PU-6**)

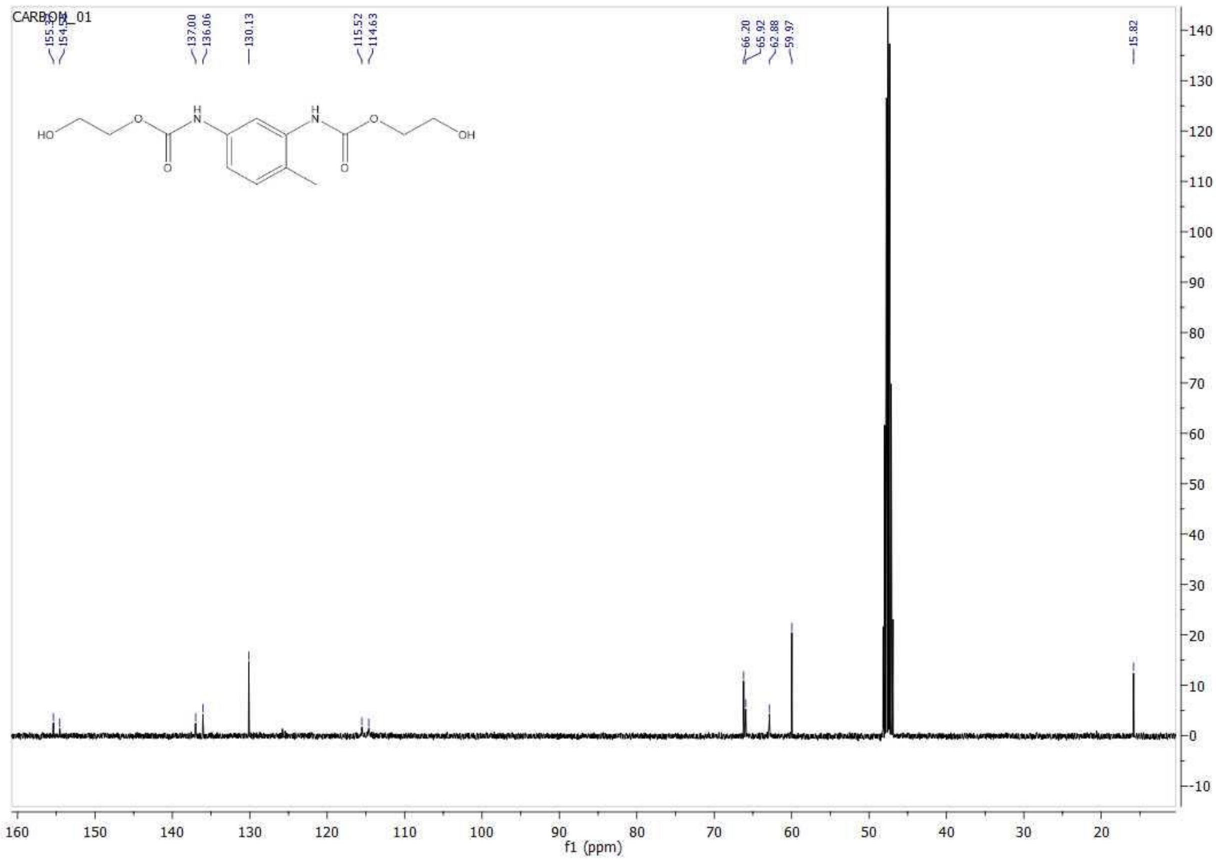

Figure S12.[13]C-NMR spectrum of *bis(2-hydroxyethyl) (4-methyl-1,3-phenylene)dicarbamate* (**PU-6**)

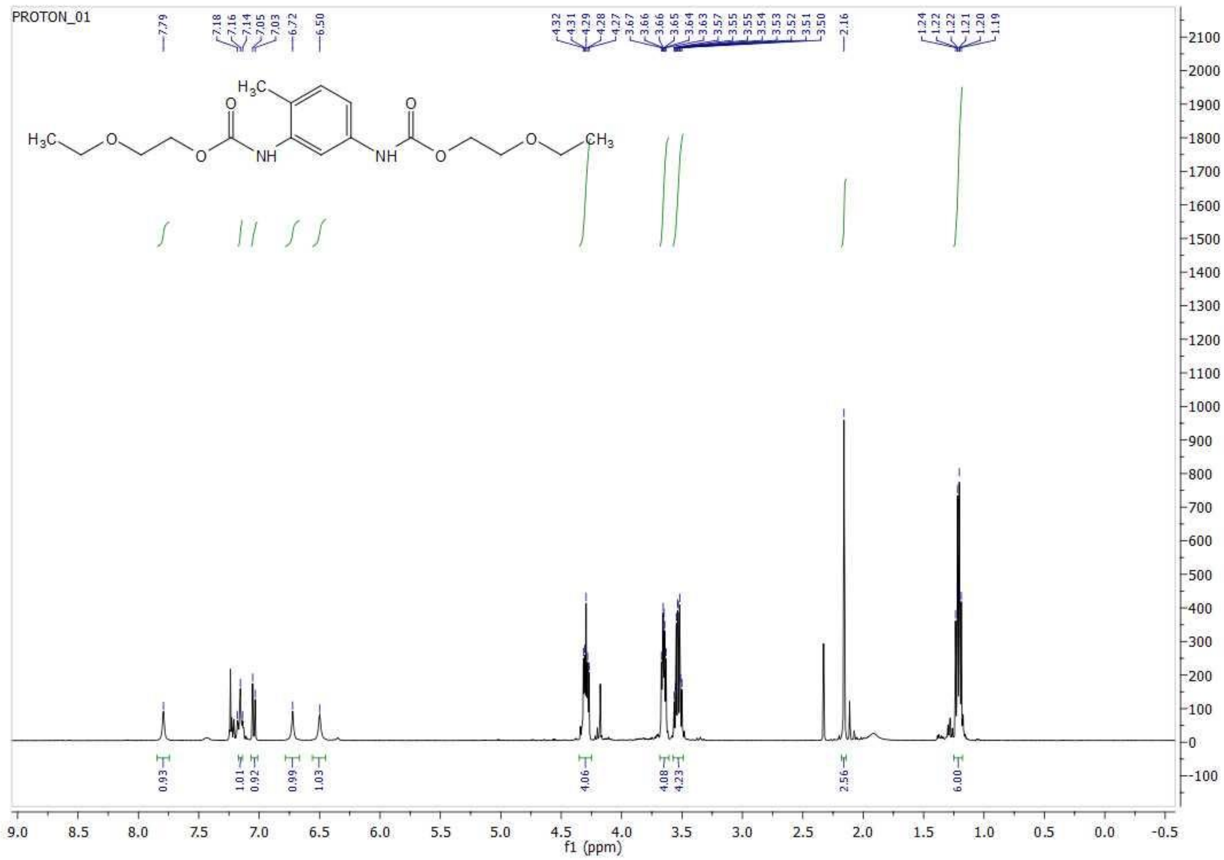

Figure S13.¹H-NMR spectrum of *bis(2-ethoxyethyl) (4-methyl-1,3-phenylene)dicarbamate* (**PU-7**)

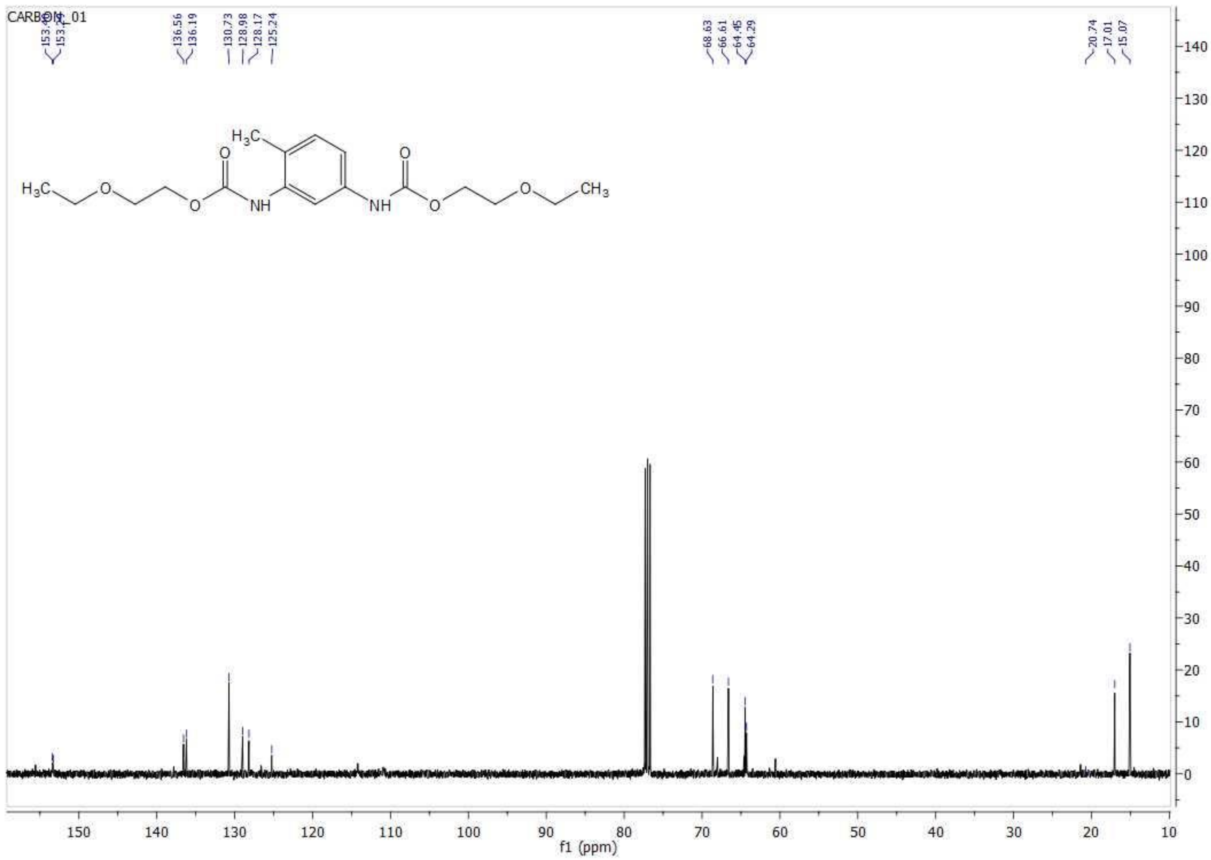

Figure S14.[13]C-NMR spectrum of *bis(2-ethoxyethyl) (4-methyl-1,3-phenylene)dicarbamate* (**PU-7**)

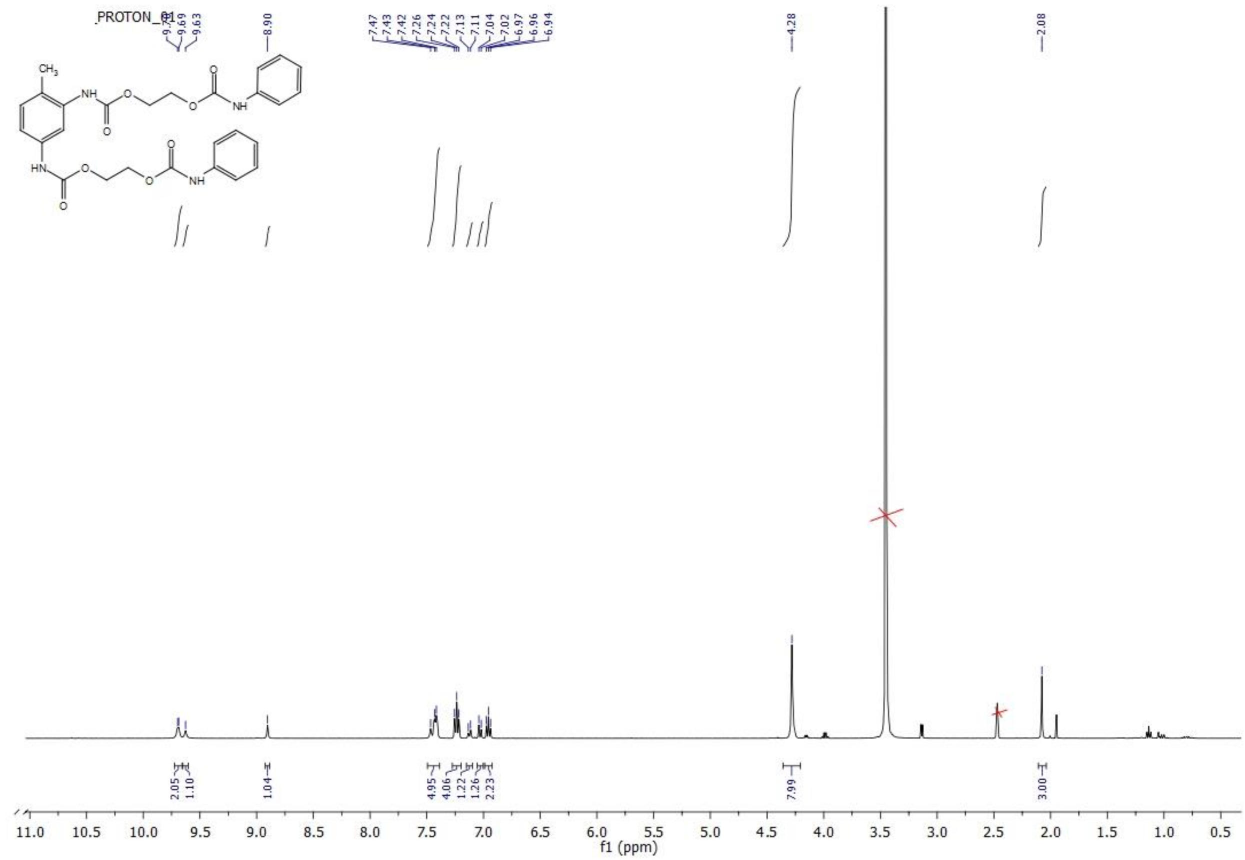

Figure S15. ^{1}H-NMR spectrum of *bis(2-((phenylcarbamoyl)oxy)ethyl) (4-methyl-1,3-phenylene)dicarbamate* (**PU-8**)

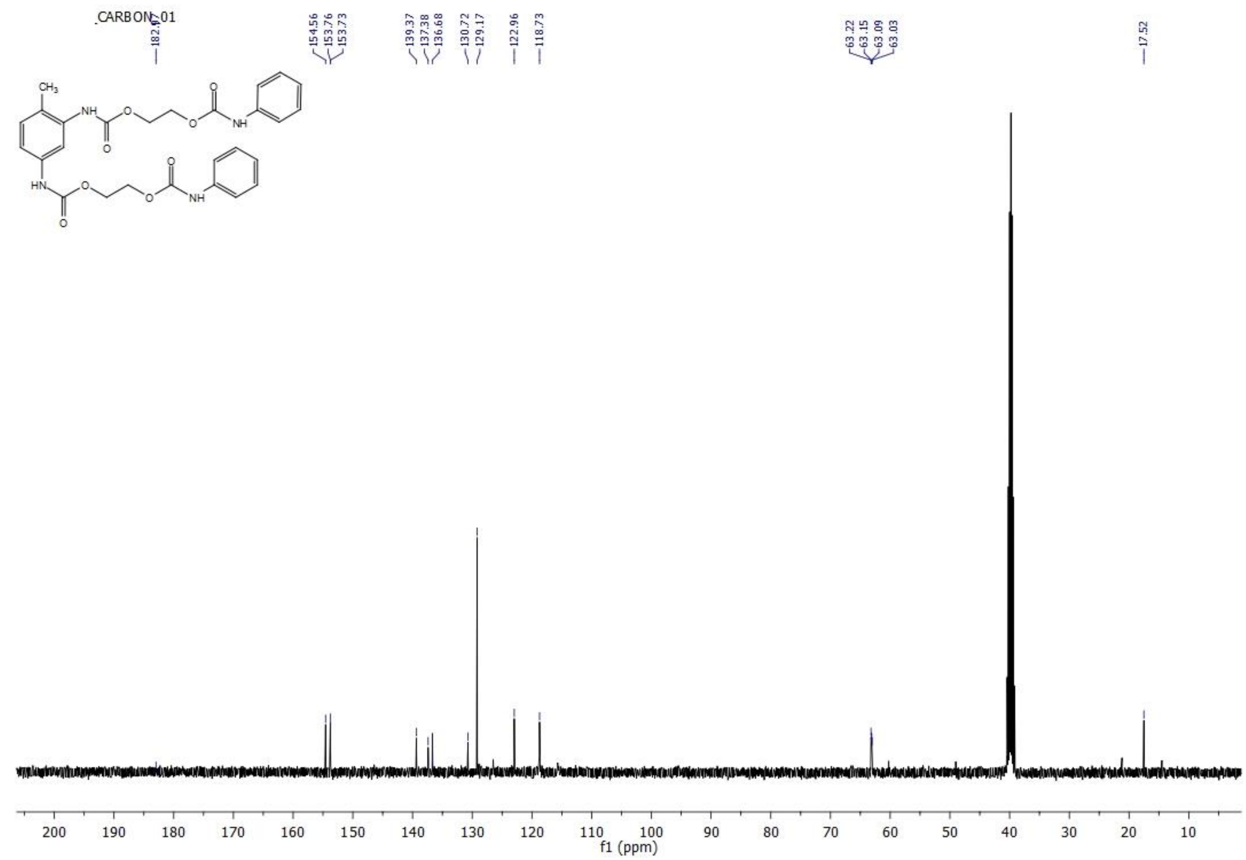

Figure S16. ^{13}C-NMR spectrum of b*is(2-((phenylcarbamoyl)oxy)ethyl) (4-methyl-1,3-phenylene)dicarbamate* (**PU-8**)

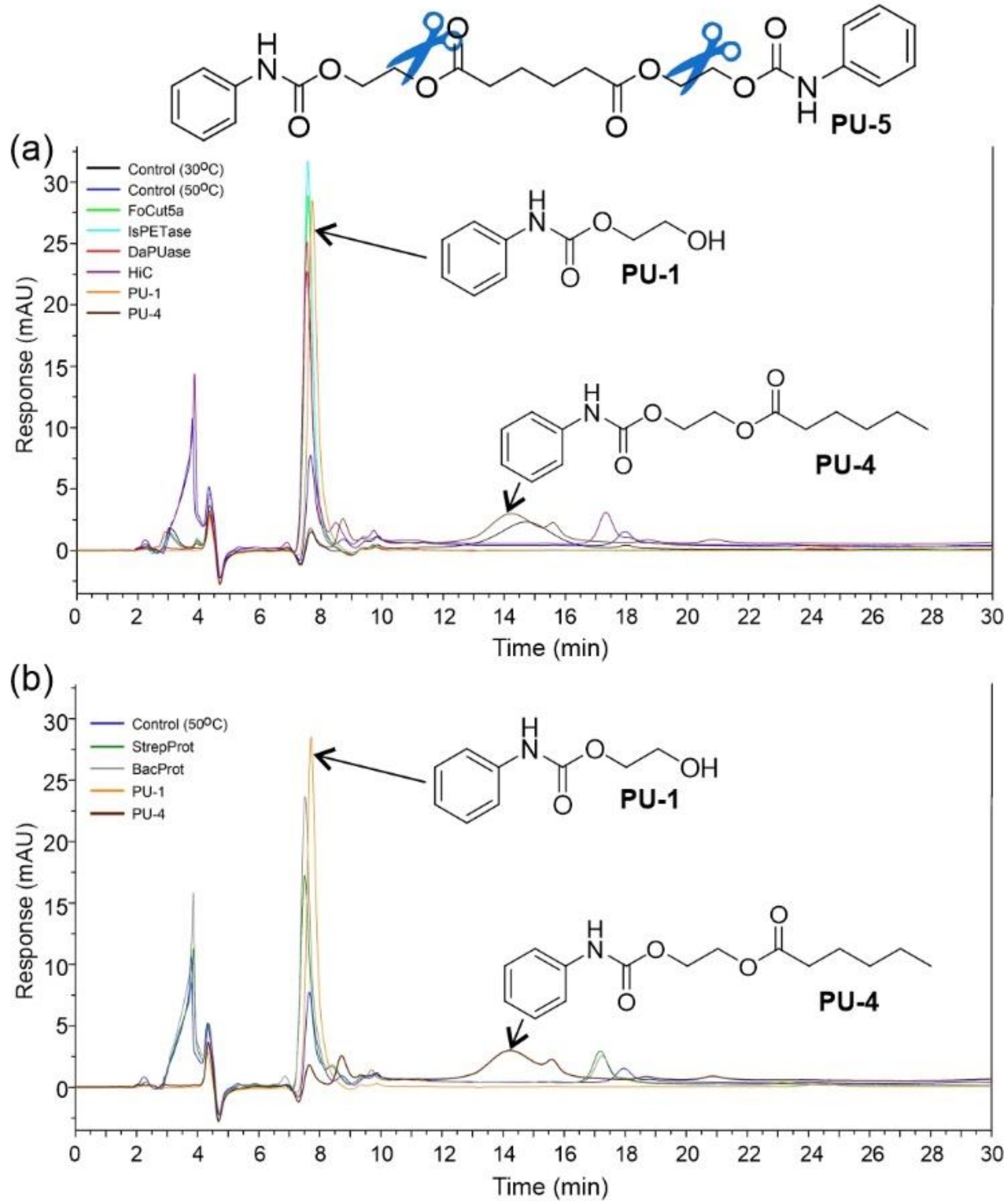

Figure S17. PU-5 degradation products (a) after incubation with a selection of esterases: FoCut5a (light green line), IsPETase (cyan line), DaPUase (red line), and HiC (purple line). Reactions without enzyme were performed at 30 °C (black line) and 50 °C (blue line); and two proteases: StrepProt (green line) and BacProt (grey line). Control reactions without enzymes were performed at 50 °C (blue line). Possible degradation products PU-1 (orange line) and PU-4 (brown line) are also shown.

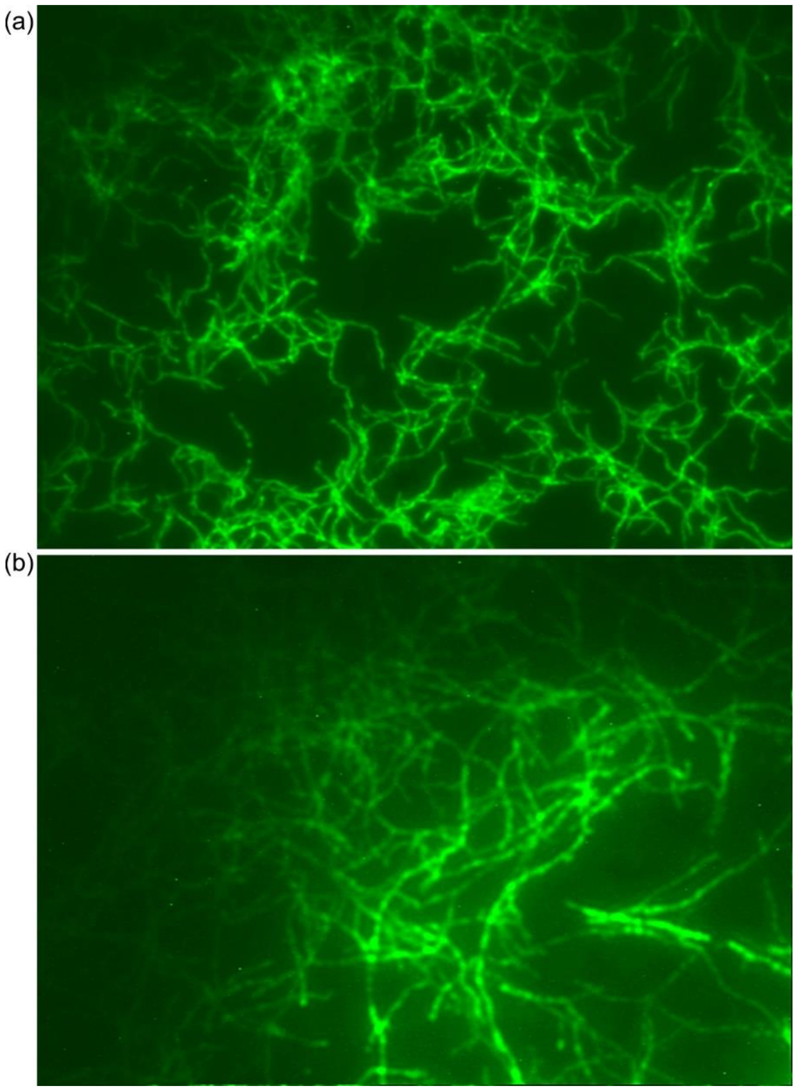

Figure S18. *Amycolatopsis mediterranei* ISP5501 cells stained with thiazole orange and visualized under

fluorescent microscope (FITC channel). 60 × magnification (a) and 100 × magnification (b).

Table S1. Solubility of PU model compounds in selection of common organic solvents.

Solvent / *compound*	EtOAc	DCM	MeOH	EtOH	DMF	DMSO
PU-1	***	***	***	***	***	***
PU-2	***	***	***	***	***	***
PU-3	***	***	***	***	***	***
PU-4	***	***	***	***	***	***
PU-5	***	***	***	***	***	***
PU-6	-	-	***	***	***	***
PU-7	***	***	***	***	***	***
PU-8	***	-	-	-	***	***

- not soluble

Solvents: EtOAc= ethylacetate; DCM=dichloromethane; MeOH= methanol EtOH= ethanol; DMF= dimethylformamide; DMSO= dimethyl sulfoxide

Table S2. List of predicted **PU-7** degradation products

Compound	Molecular mass	Molecular formula	
PU-7	354.17910	C17H26N2O6	CCOCCOC(=O)NC1=CC=C(C)C(NC(=O)OCCOCC)=C1
PU7.13	106.02660	C3H6O4	OCCOC(O)=O
PU7.11 2,4-TDA	122.08440	C7H10N2	CC1=CC=C(N)C=C1N
PU7.12	134.0579	C5H10O4	CCOCCOC(O)=O
PU7.9	166.07420	C8H10N2O2	CC1=CC=C(N)C=C1NC(O)=O
PU7.10	166.07420	C8H10N2O2	CC1=CC=C(NC(O)=O)C=C1N
PU7.6	210.06410	C9H10N2O4	CC1=CC=C(NC(O)=O)C=C1NC(O)=O
PU7.7	210.10040	C10H14N2O3	CC1=CC=C(NC(=O)OCCO)C=C1N
PU7.8	210.10040	C10H14N2O3	CC1=CC=C(N)C=C1NC(=O)OCCO
PU7.14	238.1317	C12H18N2O3	CCOCCOC(=O)NC1=CC(N)=CC=C1C
PU7.15	238.1317	C12H18N2O3	CCOCCOC(=O)NC1=CC=CC(N)=C1
PU7.4	254.09030	C11H14N2O5	CC1=CC=C(NC(O)=O)C=C1NC(=O)OCCO
PU7.5	254.09030	C11H14N2O5	CC1=CC=C(NC(=O)OCCO)C=C1NC(O)=O
PU7.16	282.1216	C13H18N2O5	CCOCCOC(=O)NC1=CC=C(C)C(NC(O)=O)=C1
PU7.17	282.1216	C13H18N2O5	CCOCCOC(=O)NC1=CC(NC(O)=O)=CC=C1C
PU7.3	298.11650	C13H18N2O6	CC1=CC=C(NC(=O)OCCO)C=C1NC(=O)OCCO
PU7.1	326.14780	C15H22N2O6	CCOCCOC(=O)NC1=CC=C(C)C(NC(=O)OCCO)=C1
PU7.2	326.14780	C15H22N2O6	CCOCCOC(=O)NC1=CC(NC(=O)OCCO)=CC=C1C

Table S3. Identification of 18 Impranil DLN degrading bacterial strains by 16S sequencing

Strain	Identificati	Sequence
MM46	*Streptomyces* sp.	TCCCGCATGGGAcGGGGTTAAAAGTTCCGGCGGtGAAgGATGAGCCCCCGGCCT ATCAGCTTGTTGGTGGGGTAATGGCCTACCAAGGCGACGACGGGTAGCCGGCC TGAGAGGGCGACCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGG GAGGCAGCAGTGGGGAATATTGCACAATGGGCGAAAGCCTGATGCAGCGACG CCGCGTGAGGGATGACGGCCTTCGGGTTGTAAACCTCTTTCAGCAGGGAAGAA GCGAAAGTGACGGTACCTGCAGAAGAAGCGCCGGCTAACTACGTGCCAGCAG CCGCGGTAATACGTAGGGCGCAAGCGTTGTCCGGAATTATTGGGCGTAAAGAG CTCGTAGGCGGCTTGTCACGTCGGATGTGAAAGCCCGGGGCTTAACCCCGGGT CTGCATTCGATACGGGCTAGCTAGAGTGTGGTAGGGGAGATCGGAATTCCTGG TGTAGCGGTGAAATGCGCAGATATCAGGAGGAACACCGGTGGCGAAGGCGGA TCTCTGGGCCATTACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGGA TTAGATACCCTGGTAGTCCACGCCGTAAACGTTGGGAACTAGGTGTTGGCGAC ATTCCACGTCGTCGGTGCCGCAGCTAACGCATTAAGTTCCCCGCCTGGGGAGT ACGGCCGCAAGGCTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCAGC GGAGCATGTGGCTTAATTCGACGCAACGCGAAGAACCTTACCAAGGCTTGACA TATACCGGAAAGCATCAGAGATGGTGCCCCCCTTGTGGTCGGTATACAGGTGG TGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGA GCGCAACCCTTGTTCTGTGTTGCCAGCATGCCCTTCGGGGTGATGGGGACTCAC AGGAGACTGCCGGGGTCAACTCGGAGGAAGGTGGGGACGACGTCAAGTCATC ATGCCCCTTATGTCTTGGGCTGCACACGTGCTACAATGGCCGGTACAATGAGCT GCGATGCCGCGAGGCGGAGCGAATCTCAAAAAcCCGGTCTCAGTTCGGATTGG GGTCTGCAACTC

MM49 *Streptomyces* sp.

GGGACGGGgTtaAAAGTTCCGGCGGtGAAGGAGACCCCCGGCCTTTCAGTgTTGG
TGGGgTAATGgCCTACCAAGgCGACGACGGTaCCGCCTGAGAGGgCGACCGCCA
cACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGgATTat
TGCACAATGGGCGAAAGCCTGATGCAGCGACGCCGCGTGAGGGATGACGGCC
TTCGGGTTGTAAACCTCTTTCAGCAGGGAAGAAGCGAAAGTGACGGTACCTGC
AGAAGAAGCGCCGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGGCG
CAAGCGTTGTCCGGAATTATTGGGCGTAAAGAGCTCGTAGGCGGCTTGTCACG
TCGGATGTGAAAGCCCGGGGCTTAACCCCGGGTCTGCATTCGATACGGGCTAG
CTAGAGTGTGGTAGGGGAGATCGGAATTCCTGGTGTAGCGGTGAAATGCGCAG
ATATCAGGAGGAACACCGGTGGCGAAGGCGGATCTCTGGGCCATTACTGACGC
TGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCCAC
GCCGTAAACGTTGGGAACTAGGTGTTGGCGACATTCCACGTCGTCGGTGCCGC
AGCTAACGCATTAAGTTCCCCGCCTGGGGAGTACGGCCGCAAGGCTAAAACTC
AAAGGAATTGACGGGGGCCCGCACAAGCAGCGGAGCATGTGGCTTAATTCGA
CGCAACGCGAAGAACCTTACCAAGGCTTGACATATACCGGAAAGCATCAGAG
ATGGTGCCCCCCTTGTGGTCGGTATACAGGTGGTGCATGGCTGTCGTCAGCTCG
TGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTTCTGTGTT
GCCAGCATGCCCTTCGGGGTGATGGGGACTCACAGGAGACTGCCGGGGTCAAC
TCGGAGGAAGGTGGGGACGACGTCAAGTCATCATGCCCCTTATGTCTTGGGCT
GCACACGTGCTACAATGGCCGGTACAATGA

MM53 *Streptomyces* sp.

TCAGCTtGTTGGTGGGgTAAtGGCCTACCAAGgCGACGACGGGTAGCCGGCCTG
AGAGGgCGACCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGA
GGCAGCAGTGGGgAATATTGCACAATGGGCGAAAGCCTGATGCAGCGACGCC
GCGTGAGGGATGACGGCCTTCGGGTTGTAAACCTCTTTCAGCAGGGAAGAAGC
GAAAGTGACGGTACCTGCAGAAGAAGCGCCGGCTAACTACGTGCCAGCAGCC
GCGGTAATACGTAGGGCGCAAGCGTTGTCCGGAATTATTGGGCGTAAAGAGCT
CGTAGGCGGCTTGTCACGTCGGATGTGAAAGCCCGGGGCTTAACCCCGGGTCT
GCATTCGATACGGGCTAGCTAGAGTGTGGTAGGGGAGATCGGAATTCCTGGTG
TAGCGGTGAAATGCGCAGATATCAGGAGGAACACCGGTGGCGAAGGCGGATC
TCTGGGCCATTACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGGATT
AGATACCCTGGTAGTCCACGCCGTAAACGTTGGGAACTAGGTGTTGGCGACAT
TCCACGTCGTCGGTGCCGCAGCTAACGCATTAAGTTCCCCGCCTGGGGAGTAC
GGCCGCAAGGCTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCAGCGG
AGCATGTGGCTTAATTCGACGCAACGCGAAGAACCTTACCAAGGCTTGACATA
TACCGGAAAGCATCAGAGATGGTGCCCCCCTTGTGGTCGGTATACAGGTGGTG
CATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGC
GCAACCCTTGTTCTGTGTTGCCAGCATGCCCTTCGGGGTGATGGGGACTCACAG
GAGACTGCCGGGGTCAACTCGGAGGAAGGTGGGGACGACGTCAAGTCATCAT
GCCCCTTATGTCTTGGGCTGCACACGTGCTACAATGGCCGGTACAATGAGCTGC

MM55 *Streptomyces* sp.

GATGACCCCGCGgCCTATCAGCTtGTTGGTGGGgTAATGgCCTACCAAGGCGAC
GACGGgTAGCCGGCCTGAGAGGgCGACCGgCCACACTGGGACTGAGACACGGC
CCAGACTCCTACGGGAGGCAGCAGTGGGgAATATTGCACAATGGGCGAAAGC
CTGATGCAGCGACGCCGCGTGAGGGATGACGGCCTTCGGGTTGTAAACCTCTT
TCAGCAGGGAAGAAGCGAAAGTGACGGTACCTGCAGAAGAAGCGCCGGCTA
ACTACGTGCCAGCAGCCGCGGTAATACGTAGGGCGCAAGCGTTGTCCGGAATT
ATTGGGCGTAAAGAGCTCGTAGGCGGCTTGTCACGTCGGATGTGAAAGCCCGG
GGCTTAACCCCGGGTCTGCATTCGATACGGGCTAGCTAGAGTGTGGTAGGGGA
GATCGGAATTCCTGGTGTAGCGGTGAAATGCGCAGATATCAGGAGGAACACC
GGTGGCGAAGGCGGATCTCTGGGCCATTACTGACGCTGAGGAGCGAAAGCGT
GGGGAGCGAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACGTTGGGA
ACTAGGTGTTGGCGACATTCCACGTCGTCGGTGCCGCAGCTAACGCATTAAGTT
CCCCGCCTGGGGAGTACGGCCGCAAGGCTAAAACTCAAAGGAATTGACGGGG
GCCCGCACAAGCAGCGGAGCATGTGGCTTAATTCGACGCAACGCGAAGAACC
TTACCAAGGCTTGACATATACCGGAAAGCATCAGAGATGGTGCCCCCCTTGTG
GTCGGTATACAGGTGGTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGG
TTAAGTCCCGCAACGAGCGCAACCCTTGTTCTGTGTTGCCAGCATGCCCTTCGG
GGTGATGGGGACTCACAGGAGACTGCCGGGGTCAACTCGGAGGAAGGTGGGG
ACaACGTCAAGTCATCATGCCCCTTA-
GTCTTGGGCTGCACACGTGCTACAATGGCCGGTACAATGA-CTGC-
ATGCCGCGA

MM61 *Streptomyces* sp.

AAGATGACCCCGCGgCCTTTCAGCTTgTTGGTGGGgTAAtGGCCTACCAAGGCG
ACGACGGGTAGCCGGCCTGAGAGGGCGACCGGCCACACTGGGACTGAGACAC
GGCCCAGACTCCTACGGGAGGCAGCAGTGGGgAATATTGCACAATGGGCGAA
AGCCTGATGCAGCGACGCCGCGTGAGGGATGACGGCCTTCGGGTTGTAAACCT
CTTTCAGCAGGGAAGAAGCGAAAGTGACGGTACCTGCAGAAGAAGCGCCGGC
TAACTACGTGCCAGCAGCCGCGGTAATACGTAGGGCGCAAGCGTTGTCCGGAA
TTATTGGGCGTAAAGAGCTCGTAGGCGGCTTGTCACGTCGGATGTGAAAGCCC
GGGGCTTAACCCCGGGTCTGCATTCGATACGGGCTAGCTAGAGTGTGGTAGGG
GAGATCGGAATTCCTGGTGTAGCGGTGAAATGCGCAGATATCAGGAGGAACA
CCGGTGGCGAAGGCGGATCTCTGGGCCATTACTGACGCTGAGGAGCGAAAGC
GTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACGTTGGG
AACTAGGTGTTGGCGACATTCCACGTCGTCGGTGCCGCAGCTAACGCATTAAG
TTCCCCGCCTGGGGAGTACGGCCGCAAGGCTAAAACTCAAAGGAATTGACGG
GGGCCCGCACAAGCAGCGGAGCATGTGGCTTAATTCGACGCAACGCGAAGAA
CCTTACCAAGGCTTGACATATACCGGAAAGCATCAGAGATGGTGCCCCCCTTG
TGGTCGGTATACAGGTGGTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTG
GGTTAAGTCCCGCAACGAGCGCAACCCTTGTTCTGTGTTGCCAGCATGCCCTTC
GGGGTGATGGGGACTCACAGGAGACTGCCGGGGTCAACTCGGAGGAAGGTGG
GGACGACGTCAAGTCATCATGCCCCTTATGTCTTGGGCTGCACACGTGCTACAA
TGGCCGGTACAATGAGCTGCaATGCCcCGAGGCGGA

BPNJ14 *Streptomyces* sp.

AAAGATGAgCCCGCGgCCTTTCAGCTTGTtGGTGGGGTAAtGGCCTACCAAGGC
GACGACGGGTAGCCGGCCTGAGAGGGCGACCGGCCACACTGGGACTGAGACA
CGGCCCAGACTCCTACGGGAGGCAGCAGTGGGgAATATTGCACAATGGGCGA
AAGCCTGATGCAGCGACGCCGCGTGAGGGATGACGGCCTTCGGGTTGTAAACC
TCTTTCAGCAGGGAAGAAGCGAAAGTGACGGTACCTGCAGAAGAAGCGCCGG
CTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGGCGCAAGCGTTGTCCGGA
ATTATTGGGCGTAAAGAGCTCGTAGGCGGCTTGTCACGTCGGATGTGAAAGCC
CGGGGCTTAACCCCGGGTCTGCATTCGATACGGGCTAGCTAGAGTGTGGTAGG
GGAGATCGGAATTCCTGGTGTAGCGGTGAAATGCGCAGATATCAGGAGGAAC
ACCGGTGGCGAAGGCGGATCTCTGGGCCATTACTGACGCTGAGGAGCGAAAG
CGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACGTTGG
GAACTAGGTGTTGGCGACATTCCACGTCGTCGGTGCCGCAGCTAACGCATTAA
GTTCCCCGCCTGGGGAGTACGGCCGCAAGGCTAAAACTCAAAGGAATTGACG
GGGGCCCGCACAAGCAGCGGAGCATGTGGCTTAATTCGACGCAACGCGAAGA
ACCTTACCAAGGCTTGACATATACCGGAAAGCATCAGAGATGGTGCCCCCCTT
GTGGTCGGTATACAGGTGGTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTT
GGGTTAAGTCCCGCAACGAGCGCAACCCTTGTTCTGTGTTGCCAGCATGCCCTT
CGGGGTGATGGGGACTCACAGGAGACTGCCGGGGTCAACTCGGAGGAAGGTG
GGGACGACGTCAAGTCATCATGCCCCTTATGTCTTGGGCTGCACACGTGCTACA
ATGGCCGGTACAATGAaCTGCtATGCCGCGAGGCGGAGCGAATCTCAAAAGCC
GGTC

BPS44 *Streptomyces* sp.

TGGtgAGGTAGtGGCTCCCCAAGGCGACGACGGgTAGCCGCCCTGAGAGGGCGA
CCGGCCACCCTGGGACTGAGACCCGGCCCAGATTCCTACGGGAGGCAGCAGT
GGGGAATATtGCACAATGGGCGAAAGCCTGATGCAGCGACGCCGCGTGAGGG
ATGACGGCCTTCGGGTTGTAAACCTCTTTCAGCAGGGAAGAAGCGAAAGTGAC
GGTACCTGCAGAAGAAGCGCCGGCTAACTACGTGCCAGCAGCCGCGGTAATA
CGTAGGGCGCAAGCGTTGTCCGGAATTATTGGGCGTAAAGAGCTCGTAGGCGG
TCTGTCGCGTCGGATGTGAAAGCCCGGGGCTTAACCCCGGGTCTGCATTCGATA
CGGGCAGACTAGAGTGTGGTAGGGGAGATCGGAATTCCTGGTGTAGCGGTGA
AATGCGCAGATATCAGGAGGAACACCGGTGGCGAAGGCGGATCTCTGGGCCA
TTACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCT
GGTAGTCCACGCCGTAAACGGTGGGAACTAGGTGTTGGCtACATTCCACCGTGT
GCCCAGCTAACcCtTTAtTTCCCCGCCTGG

FIA17 *Streptomyces* sp.

TAATGGTTCACCAAGGCGACGACGGGTAGCCGGCCTGAGAGGGCGACCGGccA
CCCTGGGACTGAGACCGGCCCAGATTCCTACGGGAGGCAGCAGTGGGGAATaT
TGCACAATGGGCGAAAGCCTGATGCAGCGACGCCGCGTGAGGGATGACGGCC
TTCGGGTTGTAAACCTCTTTCAGCAGGGAAGAAGCGAAAGTGACGGTACCTGC
AGAAGAAGCGCCGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGGCG
CAAGCGTTGTCCGGAATTATTGGGCGTAAAGAGCTCGTAGGCGGCTTGTCACG
TCGATTGTGAAAGCCCGAGGCTTAACCTCGGGTCTGCAGTCGATACGGGCTAG
CTAGAGTGTGGTAGGGGAGATCGGAATTCCTGGTGTAGCGGTGAAATGCGCAG
ATATCAGGAGGAACACCGGTGGCGAAGGCGGATCTCTGGGCCATTACTGACGC
TGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCCAC
GCCGTAAACGGTGGGAACTAGGTGTTGGCGACATTCCACGTCGTCGGTGCCGC
AGCTAACGCATTAAGTTCCCCGCCTGGGGAGTACGGCCGCAAGGCTAAAACTC
AAAGGAATTGACGGGGGCCCGCACAAGCAGCGGAGCATGTGGCTTAATTCGA
CGCAACGCGAAGAACCTTACCAAGGCTTGACATACACCGGAAAGCATCAGAG
ATGGTGCCCCCCTTGTGGTCGGgGTACAGGTGGTGCATGGCTGTCGTCAaCTCtT
GTCG

JRD13 *Achromobacter sp.*

GCCTCCCTTACGGTTAGGCTAACTACTTCTGGTAAAACCCACTCCCATGGTGTG
ACGGGCGGTGTGTACAAGGACCCGGGAACGTATTCACCGCGACATGCTGATCC
GCGATTACTAGCGATTCCGACTTCACGCAGTCGAGTTGCAGACTGCGATCCGG
ACTACGATCGGGTTTCTGGGATTGGCTCCCCCTCGCGGGTTGGCGACCCTCTGT
CCCGACCATTGTATGACGTGTGAAGCCCTACCCATAAGGGCCATGAGGACTTG
ACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGTCTCATTAGAGTGCCCTT
TCGTAGCAACTAATGACAAGGGTTGCGCTCGTTGCGGGACTTAACCCAACATC
TCACGACACGAGCTGACGACAGCCATGCAGCACCTGTGTTCCGGTTCTCTTGCG
AGCACTTCCAAATCTCTTCGGAATTCCAGACATGTCAAGGGTAGGTAAGGTTTT
TCGCGTTGCATCGAATTAATCCACATCATCCACCGCTTGTGCGGGTCCCCGTCA
ATTCCTTTGAGTTTTAATCTTGCGACCGTACTCCCCAGGCGGTCAACTTCACGC
GTTAGCTGCGCTACTAAGGCCCGAAGGCCCCAACAGCTAGTTGACATCGTTTA
GGGCGTGGACTACCAGGGTATCTAATCCTGTTTGCTCCCCACGCTTTCGTGCAT
GAGCGTCAGTGTTATCCCAGGAGGCTGCCTTCGCCATCGGTGTTCCTCCGCATA
TCTACGCATTTCACTGCTACACGCGGAATTCCACCTCCCTCTGACACACTCTAG
CTCGGTAGTTAAAAATGCAGTTCCAAAGTTAAGCTCTGGGATTTCACATCTTTC
TTTCCGAACCGCCTGCGCACGCTTTACGCCCAGTAATTCCGATTAACGCTTGCA
CCCTACGTATTACCGCGGCTGCTGGCACGTACTTAGCCCGTGCTTATTCTGCAG
GTACCGTCCGTTCACGGGGTATTAGCCCATGACGTTTCTTTCCTGCCAAAGTGC
TTTACAACCGAAAGCCTTCATCTCAACCCCGGATGGCTGTATCAGGTTTCCTCA
TGGACAAATTTACCACTGCTGCTTCAGAAGGAAGGGGGCGGGCTTCATCCATT
GGGTGGCCTTCCCCAACCAACAAGGATCCTACCTTGGGAATCTTACCCCCCAA
TAACAAACAGAATTGCTGCACAAATATGAGGGTTTCGACCCTCCTTTCCCGAA
GAGTTTGGGGTTTTATCTTTTGCTATATACCCCCACAAGG

ST11 *Pseudomonas sp.*

AACTATTaCCGCAtACGTCCTGGGGGAgAAAGCAGGGACCcTTcgGGCCTTGcGC
TTTCAGAtGAGCCTATGTCGGATTAGcTaGTAGGtgGAGTAATGgCTCACCTAGGC
GACGATCCgTAACTGgTTTGAGAGGaTGATCAGTCACACTGGAACTGAAACCCG
GTCCAGACTCCTACGGGAGGCAGCAGTGGGgAATATTGGACAATGGGCGAAA
GCCTGATCCAGCCATGCCGGCtGTGtGAAGAAGGTCTTCGGATTGTAAAGCACT
TTAAGTTGGGAGGAAGGGCAGTAAGTTAATACCTTGCTGCTTTGACGTTACCA
ACAGAATAAGCACCGGCTAACTTCGTGCCAGCAGCCGCGGTAATACGAAGGG
TGCAAGCGTTAATCGGAATTACTGGGCGTAAAGCGCGCGTAGGTGGTTCAGCA
AGTTGGAGGTGAAATCCCCGGGCTCAACCTGGGAACTGCCTCCAAAACgACTG
gGCTAGAGTACGGTAGAGGGTAGTGGAATTTCCTGTGTAGCGGcGAAtTGCGTA
GATATAGGAAGGAACtCCAGTG

JA1 *Streptomyces* sp.

GTCCAGCAGCCGCGGTAATACGTAGGGCGCAAGCGTTGTCCGGAATTATTGGG
CGTAAAGAGCTCGTAGGCGGTctGTCGCGTCGGATGTGAAAGCCCGGGGCTTAA
CCCCGGGTCTGCATTCGATACGGGCAGACTAGAGTGTGGTAGGGGAGATCGGA
ATTCCTGGTGTAGCGGTGAAATGCGCAGATATCAGGAGGAACACCGGTGGCG
AAGGCGGATCTCTGGGCCATTACTGACGCTGAGGAGCGAAAGCGTGGGGAGC
GAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACGGTGGGAACTAGGTG
TTGGCGACATTCCACGTCGTCGGTGCCGCAGCTAACGCATTAAaTTCCCCGCCT
GGGGAGTACGGCCGCAAGtTAAAAtTCAAAGGAATTGACGGGGGCCCcCACAA
cCAGCGGAGATGTGtGtTTAATTCACGC

VB659 *Streptomyces sp.*

AAGGGGTTGGGCCACCGGCTTCGGGTGTTACCGACTTTCGTGACGTGACGGGC
GGTGTGTACAAGGCCCGGGAACGTATTCACCGCAGCAATGCTGATCTGCGATT
ACTAGCGACTCCGACTTCATGGGGTCGAGTTGCAGACCCCAATCCGAACTGAG
ACCGGCTTTTTGAGATTCGCTCCACCTCGCGGTATCGCAGCTCATTGTACCGGC
CATTGTAGCACGTGTGCAGCCCAAGACATAAGGGGCATGATGACTTGACGTCG
TCCCCACCTTCCTCCGAGTTGACCCCGGCGGTCTCCCGTGAGTCCCCAGCACCA
CAAGGGCCTGCTGGCAACACGGGACAAGGGTTGCGCTCGTTGCGGGACTTAAC
CCAACATCTCACGACACGAGCTGACGACAGCCATGCACCACCTGTACACCGA
CCACAAGGGGGCGCCTGTCTCCAGACGTTTCCGGTGTATGTCAAGCCTTGGTA
AGGTTCTTCGCGTTGCGTCGAATTAAGCCACATGCTCCGCCGCTTGTGCGGGCC
CCCGTCAATTCCTTTGAGTTTTAGCCTTGCGGCCGTACTCCCCAGGCGGGGCAC
TTAATGCGTTAGCTGCGGCACGGACAACGTGGAATGTTGCCCACACCTAGTGC
CCACCGTTTACGGCGTGGACTACCAGGGTATCTAATCCTGTTCGCTCCCCACGC
TTTCGCTCCTCAGCGTCAGTATCGGCCCAGAGATCCGCCTTCGCCACCGGTGTT
CCTCCTGATATCTGCGCATTTCACCGCTACACCAGGAATTCCGATCTCCCCTAC
CGAACTCTAGCCTGCCCGTATCGACTGCAGACCCGGGGTTAAGCCCCGGGCTT
TCACAACCGACGTGACAAGCCGCCTACGAGCTCTTTACGCCCAATAATTCCGG
ACAACGCTTGCGCCCTACGTATTACCGCGGCTGCTGGCACGTAGTTAGCCGGC
GCTTCTTCTGCAGGTACCGTCACTTTCGCTTCTTCCCTGCTGAAAGAGGTTTACA
ACCCGAAGGCCGTCATCCTTCACGCGGCGTCGCTGCATCAGGCTTTCGCCCATT
GGGCAATATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGCCGGGTCTCAATCC
CAGTGTGGCCGGTCGCCTTTCAGGGCGGGTACCCGTCGTCGCCTTGGGGAGCC
ACTACCTCCCCACAAGCTGAAAGGCCCGGGTCCTCCTGAC

BV365 *Streptomyces sp.*

CCCTTCGGGGTGGATTAGTGGCGAACGGGTGAGTAACACGTGGGCAATCTGCC
CTTCACTCTGGGACAAGCCCTGGAAACGGGGTCTAATACCGGATAACACTCTG
TCCCGCATGGGACGGGGTTAAAAGCTCCGGCGGGGAAGGATGAGCCCGCGGC
CTATCAGCTTGTTGGTGGGGTAATGGCCTACCAAGGCGACCACCGGTAGCCGG
CCTGAGAGGGCGACCGGCCACACTGGGACTGAAACACGGCCCAAACTCCTAC
GGGAGGCAGCAGTGGGGAATATTGCACAATGGGCGAAAGCCTGATGCAGCGA
CCCCCCGTGAGGGATGACGGCCTTCGGGTTGTAAACCTCTTTCAGCAGGGAAG
AAGCGAAAGTGACGGTACCTGCAGAAGAAGCGCCGGCTAACTACGTGCCAGC
AGCCGCGGTAATACCTAGGGCGCAATGCGTGTCGGAAATTATAGGCGTTAAAG
AGCTCGTAGGCGGCTTGTCACGTCGGATGTGTGAAAGCCCGGGGCTTAACCC
CGGGTCTGCATTCGATACGGGCTAGCTAGAGTGTGGTAGGGGAGATCGGAATT
CCTGGTGTAGCGGTGAAATGCGCAGATATCAAGAGGAACACCGGTGGCGAAG
GCGGATCTCTGGGCCATTACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAA
CAGGATTAGATACCCCTGGTAGTCCCCGCCGTAAACCTTGGGAACTACGTGTT
GGGCGACATTTCCACGTCGATCGGTGCCGCATCTAACGCATTAAGTTCCCCCGC
CTGGGGTAGTACGGCCCGCACAGGCTAAACTCCAAAGCATTTGACCGGGGGCC
CGCACCAAGCCAGCGGGAACTGGCTTAATTCGACGCAACGCGAAGAACCTTA
CCAAGGCTTGACATATACCGGAAAGCATCAGAGATGGTGCCCCCCTTGTGGTC
GGTATACAGGTGGTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTA
AGTCCCGCAACGAGCGCAACCCTTGTTCTGTGTTGCCAGCATGCCCTTCGGGGT
GATGGGGACTCACAGGAGACTGCCGGGGTCAACTCGGAGGAAGGTGGGGACG
ACGTCAAGTCATCATGCCCCTTATGTCTTGGGCTGCACACGTGCTACAATGGCC
GGTACAATGAGCTGCGATGCCGCGAGGCGGAGCGAATCTCAAAAAGCCGGTC
TCAGTTCGGATTGGGGTCTGCAACTCGACCCCATGAAGTCGGAGTTGCTAGTA
ATCGCAGATCAGCATTGCTGCGGTGAATACGTTCCCGGGCCTTGTACACACCG
CCCGTCACGTCACGAAAGTCGGTAACACCCGAAGCCGGTGGCCCAACCCCTTG
TGGGA

RUJ1 *Streptomyces* sp.

GCCCCGGGCcTTTAAGTTAgTTGGGGGGGTaGAAGTTCCCCCAGGCGGCGaCCG
GTAGCCGgCTTGAGAGGGCACCCGCCCCAACTGGGACTGAGACCCGGCCCAG
ACTCCTACGGGAGGCAGCAGTGGGAATTATGCACAATGGGCGAAAGCCTGAT
GCAGCGACGCCGCGTGAGGGATGACGGCCTTCGGGTTGTAAACCTCTTTCAGC
AGGGAAGAAGCGAAAGTGACGGTACCTGCAGAAaAAGCGCCGGCTAACTACG
TGCCAGCAGCCGCGGTAATACGTAGGGCGCAAGCGTTGTCCGGAATTATTGGG
CGTAAAGAGCTCGTAGGCGGCTTGTCACGTCGGTTGTGAAAGCCCGGGGCTTA
ACCCCGGGTCTGCAGTCGATACGGGCAGGCTAGAGTGTGGTAGGGGAGATCG
GAATTCCTGGTGTAGCGGTGAAATGCGCAGATATCAGGAGGAACACCGGTGG
CGAAGGCGGATCTCTGGGCCATTACTGACGCTGAGaAGCGAAAGCGTGGGGAG
CGAACAGGATTAGATACCCTGGTAGTCCACGCCtGTAAACGGTGGGAACTAGG
TGTTGGCGATTCCcCGTCTCGGTGCC

TIT2 *Streptomyces* sp.

tTGGTGGGgTAATGGCCTACCAAGGCGACGACGGGTAGCCGGCCTGAGAGGGC
GaCCGGCCACACTGGGACTGGGACCCGGCCCAGACTCCTACGGGAGGCAGCA
GTGGGGAATATTGCACAATGGGCGAAAGCCTGATGCAGCGACGCCGCGTGAG
GGATGACGGCCTTCGGGTTGTAAACCTCTTTCAGCAGGGAAGAAGCGAAAGTG
ACGGTACCTGCAGAAGAAGCGCCGGCTAACTACGTGCCAGCAGCCGCGGTAA
TACGTAGGGCGCAAGCGTTGTCCGGAATTATTGGGCGTAAAGAGCTCGTAGGC
GGCTTGTCACGTCGGATGTGAAAGCCCGGGGCTTAACCCCGGGTCTGCATTCG
ATACGGGCTAGCTAGAGTGTGGTAGGGGAGATCGGAATTCCTGGTGTAGCGGT
GAAATGCGCAGATATCAGGAGGAACACCGGTGGCGAAGGCGGATCTCTGGGC
CATTACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACC
CTGGTAGTCCACGCCGTAAACGTTGGGAACTAGGTGTTGGCGACATTCCACGT
CGTCGGTGCCGCAGCTAACGCATTAAGTTCCCCGCCTGGGGAGTACGGCCGCA
AGGCTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCAGCGGAGCATGT
GGCTTAATTCGACGCAACGCGAAGAACCTTACCAAGGCTTGACATATACCGGA
AAGCATCAGAGATGGTGCCCCCCTTGTGGTCGGaATACAGGTGGTGCATGGCT
GTCGTCAaCTCGTGTCGTGAaATGTTGGGTTAAGTCCCGCAACGAGCGCAACCC
TTGTTCTGgGTTGCCAGCATGCCCTTCGGGGTGATGGGGATACAGGAaACTGCC
GGGGTCAcCTCGGAGGAAGTGGGGAC

TIT7 *Achromobacter* sp.

CCCTTTTaGAGCGGCCGAtATTgGATTAGCTAGTtGGTGGGGtAATGgCTCACCAa
GGCGACGATCCGTAGTTGGTTtGGGAGGACGaCCAGCCCCATTGGgATTGAGAC
CGGCCCAGATTCcTACGGgAGGCAGCAGTGGGgaATTTTGGACAATGGGGGAAA
cCCTGATCCAGCCATCCCGCGTGTGCGATGAAGGCCTTCGGGTTGTAAAGCACT
TTtGGCAGGAAAGAAACGTCATGGGCTAATACCCCGTGAAACTGACGGTACCT
GCAGAATAAGCACCGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGG
TGCAAGCGTTAATCGGAATTACTGgGCGTAAAGCGTGCGCAGGCGGTTCGGAA
AGAAAGATGTGAAATCCCAGAGCTTAACTTTGGAACTGCATTTTTAACTACCG
AGCTAGAGTGTGTCAGAGGGAGGTGGAATTCCGCGTGTAGCAGTGAAATGCGT
AGATATGCGGAGGAACACCGATGGCGAAGGCAGCCTCCTGGGATAACACTGA
CGCTCATGCACGAAAGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTC
CACGCCCTAAACGATGTCAACTAGCTGTTGGGGCCTTCGGGCCTTAGTAGCGC
AGCTAACGCGTGAAGTTGACCGCCTGGGGAGTACGGTCGCAAGATTAAAACTC
AAAGGAATTGACGGGGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGA
TGCAACGCGAAAAACCTTACCTACCCTTGACATGTCTGGAATTCCGAAGAGAT
TTGGAAGTGCTCGCAAGAGAACCGGAACACAGGTGCTGCATGGCTGTCGTCAG
CTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCATT
AtTTGCTACGAAAGGGCACTCTAATGAGACTGCCGGTGACAAACCGGAGGAAG
GTGGGGATGACGTCAAGTCCTCATGGCCCTTATGGGTAGGGCTTCAaACGTCAT
ACAATGGTCGGGACgGAGGGTCGCCcACCCGCGAGGGGGAGCCAATCCCAaAA
ACCCcAaCcTAaTCCGGATCGCACTGCA

44 *Pseudomonas* sp.

AGTCGAGCGGTAGAGAGAAGCTTGCTTCTCTTGAGAGCGGCGGACGGGTGAGT
AATGCCTAGGAATCTGCCTGGTAGTGGGGGATAACGTTCGGAAACGAACGCTA
ATACCGCATACGTCCTACGGGAGAAAGCAGGGGACCTTCGGGCCTTGCGCTAT
CAGATGAGCCTAGGTCGGATTAGCTAGTTGGTGAGGTAATGGCTCACCAAGGC
GACGATCCGTAACTGGTCTGAGAGGATGATCAGTCACACTGGAACTGAGACAC
GGTCCAGACTCCTACGGGAGGCAGCAGTGGGGAATATTGGACAATGGGCGAA
AGCCTGATCCAGCCATGCCGCGTGTGTGAAGAAGGTCTTCGGATTGTAAAGCA
CTTTAAGTTGGGAGGAAGGGCAGTTACCTAATACGTGATTGTTTTGACGTTACC
GACAGAATAAGCACCGGCTAACTCTGTGCCAGCAGCCGCGGTAATACAGAGG
GTGCAAGCGTTAATCGGAATTACTGGGCGTAAAGCGCGCGTAGGTGGTTTGTT
AAGTTGGATGTGAAATCCCCGGGCTCAACCTGGGAACTGCATTCAAAACTGAC
TGACTAGAGTATGGTAGAGGGTGGTGGAATTTCCTGTGTAGCGGTGAAATGCG
TAGATATAGGAAGGAACACCAGTGGCGAAGGCGACCACCTGGACTAATACTG
ACACTGAGGTGCGAAAGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGT
CCACGCCGTAAACGATGTCAACTAGCCGTTGGAAGCCTTGAGCTTTTAGTGGC
GCAGCTAACGCATTAAGTTGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAA
CTCAAATGAATTGACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTC
GAAGCAACGCGAAGAACCTTACCAGGCCTTGACATCCAATGAACTTTCTAGAG
ATAGATTGGTGCCTTCGGGAACATTGAGACAGGTGCTGCATGGCTGTCGTCAG
CTCGTGTCGTGAGATGTTGGGTTAAGTCCCGTAACGAGCGCAACCCTTGTCCTT
AGTTACCAGCACGTAATGGTGGGCACTCTAAGGAGACTGCCGGTGACAAACC
GGAGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGGCCTGGGCTAC
ACACGTGCTACAATGGTCGGTACAGAGGGTTGCCAAGCCGCGAGGTGGAGCT
AATCCCATAAAACCGATCGTAGTCCGGATCGCAGTCTGCAACTCGACTGCGTG
AAGTCGGAATCGCTAGTAATCGCGAATCAGAATGTCGCGGTGAATACGTTCCC
GGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCACCAGAAGTA
GCTAGTCTAACC

MUG-A3 *Rhodococcus* sp.

CGACGGCTCCCTCCCACAAGGGGTTAAGCCACCGGCTTCGGGTGTTACCGACT
TTCATGACGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCAGC
GTTGCTGATCTGCGATTACTAGCGACTCCGACTTCACGGGGTCGAGTTGCAGAC
CCCGATCCGAACTGAGACCAGCTTTAAGGGATTCGCTCCACCTCACGGTCTCG
CAGCCCTCTGTACTGGCCATTGTAGCATGTGTGAAGCCCTGGACATAAGGGGC
ATGATGACTTGACGTCGTCCCCACCTTCCTCCGAGTTGACCCCGGCAGTCTCTT
ACGAGTCCCCACCATAACGTGCTGGCAACATAAGATAGGGGTTGCGCTCGTTG
CGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAaGCCATGCACCAC
CTGTATACCGACCACAAGGGGGGCCACATCTCTGCAGCTTTCCGGTtATATGTC
AAACCCAGGTAAaGGTTCTTCGCGTTGCATCGAAaTTAATCCACATGCTCCGCC
GCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTTAGCCTTGCGGCCGTACTCCC
CAGGCGGGGCGCTTAATGCGTTAGCTACGGCACGGATTCCGTGGAAGGAACCC
ACACCTAGCGCCCACCGTTTACGGCGTGGACTACCAGGGTATCTAATCCTGTTC
GCTACCCACGCTTTCGTTCCTCAGCGTCAGTTACTGCCCAGAGACCCGCCTTCG
CCACCGGTGTTCCTCCTGATATCTGCGCATTTCACCGCTACACCAGGAATTCCA
GTCTCCCCTGCAGTACTCAAGTCTGCCCGTATCGCCTGCAAGCCAGCAGTTGAG
CTGCTGGTTTTCACAAACGACGCGACAAACCGCCTACGAACTCTTTACGCCCA
GTAATTCCGGACAACGCTTGCACCCTACGTATTACCGCGGCTGCTGGCACGTA
GTTAGCCGGTGCTTCTTCTGCAGGTACCGTCACTTGCGCTTtCGTCCCTGCTGAA
AGAGGTTTACAACCCGAAaGGCCGTCATCCCTCACGCGGCGTCGCTGCATCAG
GCTTTCGCCCATTGTGCAATATTCCCCACTGgCTGCCTCCCGTAGGAGTCTGGG
CCGTGTCTCAGTCCCAGTGTGGCCGGTCACCCTCTCAGGTCGGCTACCCGTCGT
CGCCTTGGTAGGCCATTACCCCACCAACAAGCTGATAGGCCGCGGGCCCATCC
TGCACCGATAAATCTTTCCACCACCCACCATGCGATAGGAGGTCATATCCGGT
ATTAGACCCAGTTTCCCAGGCTTATCCCGAAGTGCAGGGCAGATCACCCACGT
GTTACTCACCCGTTCGCCGCTCGTGTACCCCGAAAGGCCTTACCGCTCGAC

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AAGCCTTCGGGTGGATTAATGGCGAACGGGTGAGTAACACGTGGGTAATCTGC
CCTGCACTCTGGGATAAGCCTTGGAAACGGGGTCTAATACCGGATATCACAAT
CTCTCGCATGGGGGGTTGTTGAAAGTTCTGGCGGTGCAGGATGAACCCGCGGC
CTATCAGCTTGTTGGTGGGGTAGTGGCCTACCAAGGCGACGACGGGTAGCCGG
CCTGAGAGGGTGACCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTAC
GGGAGGCAGCAGTGGGGAATATTGCACAATGGGCGCAAGCCTGATGCAGCGA
CGCCGCGTGAGGGATGACGGCCTTCGGGTTGTAAACCTCTTTCGCCAGGGACG
AAGCGCAAGTGACGGTACCTGGATAAGAAGCACCGGCTAACTACGTGCCAGC
AGCCGCGGTAATACGTAGGGTGCGAGCGTTGTCCGGATTTATTGGGCGTAAAG
AGCTCGTAGGCGGTTTGTCGCGTCGGCCGTGAAATCTCCATGCTTAACGTGGAG
CGTGCGGTCGATACGGGCAGACTTGAGTTCGGTAGGGGAGACTGGAATTCCTG
GTGTAGCGGTGAAATGCGCAGATATCAGGAGGAACACCGGTGGCGAAGGCGG
GTCTCTGGGCCGATACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGG
ATTAGATACCCTGGTAGTCCACGCTGTAAACGTTGGGCGCTAGGTGTGGGCGA
CATCCACGTTGTCCGTGCCGTAGCTAACGCATTAAGCGCCCCGCCTGGAGAGT
ACGGCCGCAAGGCTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGC
GGAGCATGTGGATTAATTCGATGCACCCCGAAGAACCTTACGGGGCTTGGACT
GCCCCAGAATCCTCAAAATGGGGCTTCCCTTGGGTTGGGTGTACGGGGTTCGTT
GGTTGTCCT

Table S4. Possible PU depolymerization associated enzyme families in *A. mediterranei* genomes

Genome	amidases	esterases	peptidases	ureases	other α/β hydrolases
ISP5501	87	161	387	9	146
GCF_000196835.1	88	161	385	9	147
GCF_000220945.1	88	161	387	9	146
GCF_000282715.1	88	162	388	9	146
GCF_000454025.1	88	164	387	9	145
GCF_000696405.1	82	162	375	9	142
GCF_000700945.1	88	163	387	9	145
GCF_001742805.1	88	162	387	9	146