Ultrasound mediated synthesis of 2-amino-1,3-selenazoles derived from Fmoc/Boc/Z-*α*-amino acids

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Abstract

A simple and efficient one-pot synthesis of Fmoc/Boc/Z-amino acid derived 2-amino-1,3-selenazoles by the condensation of N^{α}-urethane protected amino acid derived bromomethyl ketones with selenourea under the influence of ultrasound has been described. Insertion of 2-amino-1,3-selenazole moiety in the side chains of Asp and Glu has also been achieved following the similar protocol.

Keywords: N^{α}-Protected bromoketones, selenourea, 2-amino-1,3-selenazoles

Introduction

The growing impact of organoselenium compounds in recent years has played a key role in synthetic chemistry serving versatile and useful reagents.[1] The quest for the synthesis of selenium containing compounds can be attributed to their interesting reactivity and potential biological activity. The medicinal properties of selenium derivatives are being intensively investigated in the light of their antiviral, antitumour, antimicrobial and fungicidal properties.[2] A number of biologically active compounds such as selenoamino acids,[3] selenopeptides[4] and selenocarbohydrates[5] have been prepared and subjected to biological screening owing to their structure-biological activity relationship studies. Additionally, organoselenium compounds have emerged as an exceptional class of structures that exemplify a role in biochemical processes, serving as important therapeutic agents ranging from antiviral, anticancer agents to naturally occurring food supplements.[6] In cancer prevention,[7] selenium analogs appear to be more active than their sulfur counterparts. Selenium derivatives also exhibit antioxidant and radio-protecting activity[8] and are free radical scavengers.[9] A prominent example is glutathione peroxidase, a key enzyme in antioxidant defense system[10] that contains selenium atom in its active domain. Selenoproteins occur widely in nature, a number of which have been isolated and

characterized.[11] Typically in these molecules, selenium occurs as selenocysteine,[12] considered the 21st amino acid genetically coded in DNA. In context of their biological applications as protectors of oxidant-induced DNA damage and inhibitors of inducible nitric oxide production, selenium-containing heterocycles are of particular interest. Among them, 1,3-selenazoles[13] show remarkable reactivities and chemical properties making them one of the widely studied selenium derivatives. Their potential as protein kinase activators and as superoxide anion scavengers has rendered them a distinct pharmaceutical significance.[14] Selenazofurin, a selenium analog of anti-tumor agent thiazofurin is found to be 5-10 times more cytotoxic than its sulfur counterpart against HL60 and L1210 cells *in vitro* and *in vivo.*[15]

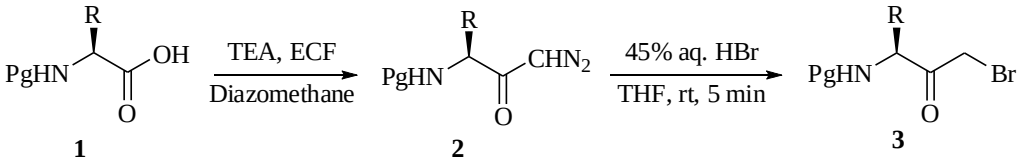
A convenient method to obtain the substituted selenazoles is the reaction between *α*-haloketones with compounds containing a selenoamide fragment, $–NH_2C(Se)R$ which is a selena-analogous Hantzsch procedure.[16] Though a routinely employed protocol, the difficulties involved in the preparation of selenoamide often paved the way for advent of other alternatives. Selenoamides have been prepared by the reaction of nitriles with H_2Se or NaSeH generated from $NaBH_4$/Se, by use of Se/CO, P_2Se_5/H_2O, Al_2Se_3.[17] The synthesis of selenoamide employs toxic Se-reagents which are difficult to store and handle. Isoselenocyanates are useful intermediates in the synthesis of heterocycles and they are easily accessible and relatively more stable. The utility of isoselenocyanates has been demonstrated in the synthesis of selenazoles,[18] selenohydantoins,[19] 1,2,3-selanadiazoles[20] and 1,3-selenazines[21] to name a few. Other alternatives for the preparation of 1,3-selenazoles include cycloaddition reactions of selenazadiene systems,[22] application of 2-chlorooxiranes which are isomeric with α-chloro carbonyl compounds.[23] 1,3,4-Selenadiazoles have been prepared by the reaction of potassium selenocyanate with hydazonoyl bromide.[24] Oxidation of aryl selenoamides with *N*-bromosuccinimide and iodine yielded 1,2,4-selenadiazoles.[25] Some of the disadvantages such as basic conditions, longer reaction duration and low yields limit the applicability of these methods. Selenourea is a convenient starting material for the synthesis of 2-amino-1,3-selenazoles.[26] Rama Rao *et al.*, reported an efficient method for the synthesis of 1,3-selenazoles using bromomethyl ketones and selenourea in the presence of *β*-cyclodextrin in water.[27] Burger *et al.*, reported the synthesis of 3-(selenazol-4-yl)alanine derivatives from hexafluroacetone protected aspartic acid in which 1,3-selenazoles were prepared by coupling selenourea to the side chain derived bromomethyl ketones under reflux conditions for 6 h.[28]

Our group is interested in the incorporation of heterocycles in amino acids as well as peptides. Recently, we reported the efficient synthesis of tetrazole analogues of amino acids,[29] 1,2,4-oxadiazole[30] and thiazole linked orthogonally urethane protected dipeptide mimetics.[31] With an aim to demonstrate the utility of N^{α}-urethane protected bromomethyl ketones, the synthesis of 2-amino-1,3-selenazole analogues of amino acids was undertaken. A simple conversion of *N*-protected-*α*-amino acid derived diazomethyl ketones into the corresponding bromomethyl ketones was achieved through acidolysis with 45% aqueous HBr. The resulting intermediates were coupled with selenourea using ultrasonication. An eco-friendly and operationally simple, ultrasound irradiation which imparts high energy into molecules offers

many advantages over conventional methods with substantial improvement in terms of reactivity and yield. The reaction was rapid and high yielding. The protocol was then extended for the preparation of unnatural amino acids containing 2-amino-1,3-selenazole moiety in side chains as well. To the best of our knowledge, this is the first report on the synthesis of α-carboxy modified 1,3-selenazole derivatives of amino acids.

Results and Discussion

In a typical reaction, *N*-Fmoc/Boc/Z-amino acid was converted into the corresponding diazomethyl ketone. This precursor was dissolved in THF, to which 45% aqueous HBr was added and the reaction was monitored through TLC and IR. Conversion of diazomethyl ketone into bromomethyl ketone was observed within 10 min through the disappearance of distinct IR peak at about 2100 cm^{-1} corresponding to the reactant and appearance of the characteristic strong peak of bromomethyl ketone at around 1735 cm^{-1}. The resulting bromomethyl ketone (Scheme 1) was obtained in near quantitative yield by diluting the reaction mixture with water. It is notable that the protocol is devoid of any workup procedure. *N*-Protected bromomethyl ketones were obtained in pure form by single crystallization from THF-water mixture. All the bromomethyl ketones were obtained as stable solids and could be stored for long time without any degradation. They were completely characterized and were found to match with the reports in the literature after comparison.[31,32]



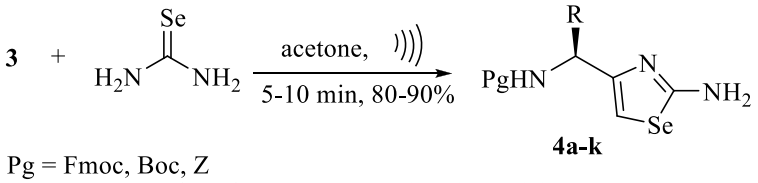
1 **2** **3**

Pg = Protecting group
TEA = Triethyl amine
ECF = Ethyl chloroformate

Scheme 1

Further, the 2-amino-1,3-selenazole analogues of Fmoc/Boc/Z-amino acids (Scheme 2) were prepared upon treating the bromomethyl ketones with selenourea through the application of Hantzsch protocol and subjected to ultrasonication using acetone as reaction solvent. The reaction was rapid as evident by the disappearance of bromomethyl ketone peak at around 1735 cm^{-1} in IR spectrum and the reaction was found to be complete in 10 min. Solvent was evaporated under reduced pressure and isolated crude 2-amino-1,3-selenazole derivatives were purified by column chromatography using $CHCl_3$/MeOH (9:1) system and completely characterized (Table 1). Next, the current protocol was examined for racemization through NMR analysis. The study was carried out by preparing the selenazole derivatives **4** from the

corresponding Fmoc-(L)-Phe and Fmoc(D)-Phe derived bromoketones and their coupling with selenourea. It was evident that the reaction sequence was free from racemization.



Pg = Fmoc, Boc, Z
R = H, Me, Bn, i-Pr, i-Bu, CH_2OBn, $(CH_2)_4NH(Z)$
Z = benzyloxycarbonyl

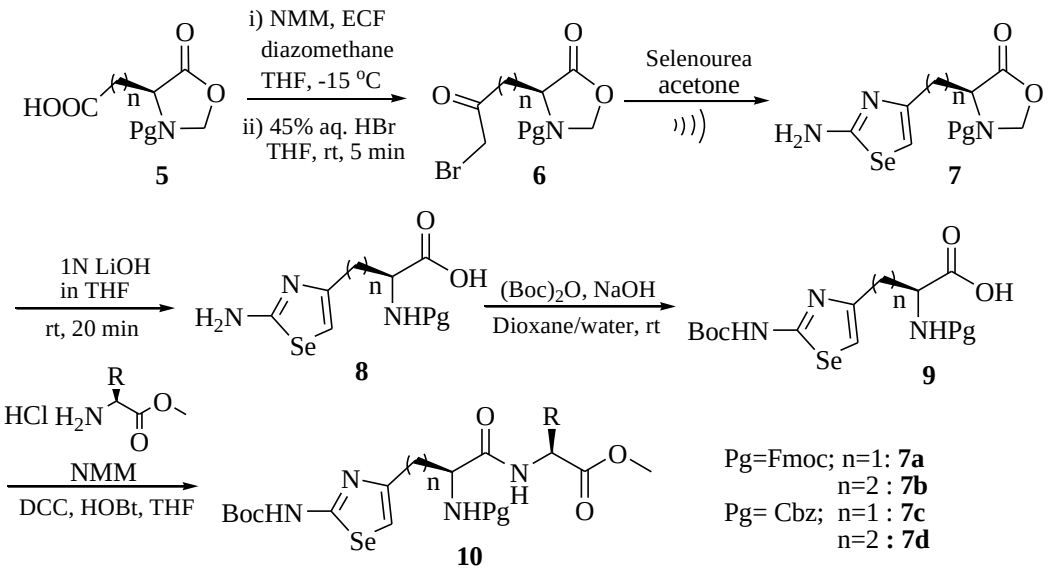
Scheme 2

Table 1. List of 2-amino-1,3-selenazole derivatives of N^{α}-Fmoc/Boc/Z-amino acids **4**

Entry	Pg	R	HRMS $[M+Na]^+$found (Calcd.)	Yield (%)
4a	Fmoc	Me	436.0543 (436.0540)	89
4b	Fmoc	Bn	512.0851 (512.0853)	90
4c	Fmoc	i-Pr	464.0858 (464.0853)	88
4d	Fmoc	i-Bu	478.1014 (478.1010)	85
4e	Fmoc	CH_2OBn	542.0950 (542.0959)	82
4f	Fmoc	$(CH_2)_4NH(Z)$	627.1480 (627.1486)	83
4g	Cbz	H	334.0075 (334.0071)	80
4h	Cbz	Me	348.0228 (348.0227)	87
4i	Cbz	Bn	424.0542 (424.0540)	84
4j	Boc	i-Pr	342.0692 (342.0697)	81
4k	Boc	$(CH_2)_4NH(Z)$	505.1331 (505.1330)	82

For the insertion of 2-amino-1,3-selenazole moiety in the side chain of amino acids, the side chain carboxyl group of Asp/Glu was converted to the corresponding bromomethyl ketone using oxazolidinone as a key intermediate. N^{α}-Protected oxazolidinones were prepared in high yields employing microwave assisted synthesis[33] starting from N^{α}-Fmoc/Z-amino acids and converted into diazomethyl ketones through the corresponding mixed anhydrides. The diazomethyl ketones were hydrolyzed with aqueous hydrobromic acid to obtain bromomethyl ketones in good yields and purity (Scheme 3). The resulting compounds were treated with selenourea in acetone and subjected to ultrasound waves for 10 min. 2-Amino-1,3-selenazole moiety was successfully incorporated in the side chains of Asp/Glu oxazolidinones. Compared to a previous report, the current protocol is rapid employing milder reaction conditions.[28] The oxazolidinone ring was selectively saponified with 1N LiOH to obtain the side chain products in good yields. Further, the amino group in the selenazole ring was orthogonally protected using Boc-urethane group. Then, the chain extension along C-terminus was demonstrated by coupling the ω-selenazole

containing α-carboxylic acid with hydrochloride salt of amino acid ester resulting in a peptide in good yield and purity (Scheme 3**,** Table 2).



Scheme 3

Table 2. *N*$^{\alpha}$-Urethane protected heteroarylalanine derivatives

Entry	Pg	R	HRMS $[M+Na]^+$found (Calcd.)	Yield (%)
10a	Fmoc	H	651.1332 (651.1334)	81
10b	Fmoc	Me	679.1648 (679.1647)	83
10c	Cbz	Bn	653.1490 (653.1493)	88
10d	Cbz	i-Pr	619.1644 (619.1647)	86

Conclusions

In conclusion, a simple route for the synthesis of *N*$^{\alpha}$-urethane protected amino acid derived 2-amino-1,3-selenazoles employing Fmoc/Boc/Z-protected bromomethyl ketones as key intermediates under ultrasonic conditions is developed. The method is also extended in inserting the selenazole moiety in side chains of Asp and Glu. Further, orthogonal protection of amino group enabled the peptide chain extension.

Experimental Section

General. All solvents were freshly distilled before use. Amino acids were used as received from Sigma-Aldrich Company. IR spectra were recorded on a Nicolet model impact 400 D FT-IR spectrometer (KBr pellets, 3 cm^{-1} resolution). ^{1}H and ^{13}C NMR spectra were recorded at 400 and 100 MHz respectively, with tetramethylsilane as an internal standard. The ^{77}Se chemical shifts are expressed in δ values deshielded with respect to neat Me_2Se in $CDCl_3$. Experimental measurements of ^{77}Se-^{1}H spin-spin coupling constants were carried out from the proton-coupled ^{77}Se NMR spectra in $Me_2Se/CDCl_3$, at 76 MHz. Mass spectra were recorded using high resolution mass spectrometer and the samples were dried under vacuum before analysis. The ultrasound bath (Elma, T 310/H) was German made and operated at 35 kHz. Unless or otherwise mentioned, all amino acids used have *L*-configuration. TLC analysis was carried out using the pre-coated silica gel G_{254} plates.

General procedure for the preparation of *N*$^{\alpha}$-Fmoc/Boc/Z-protected diazomethyl ketones
To a stirred solution of *N*$^{\alpha}$-protected amino acid (10 mmol) in THF at –15 ºC, was added TEA (1.1 mL, 10 mmol) and ethyl chloroformate (0.91 mL, 10 mmol) and stirring was continued for another 15 min at the same temperature, then diazomethane in ether (10 mL) was added at 0 ºC and stirred for 30 min. The solvent was evaporated and the residue was dissolved in CH_2Cl_2 and washed successively with 10% $NaHCO_3$ (10 mL), 10% hydrochloric acid (10 mL) or 10% citric acid (in case of Boc-amino acids), water (10 mL) and brine solution. The organic layer was dried over sodium sulphate and concentrated to yield the desired product.

General procedure for the preparation of *N*$^{\alpha}$-Fmoc/Boc/Z-protected bromomethyl ketones
To the amino acid derived diazomethyl ketone (10 mmol) in THF was added 2-3 mL of 45% aq. HBr solution at room temperature and stirring was continued for another 5 min till the starting material was completely consumed. The reaction mixture was diluted with excess of water and the precipitated solid was filtered. The product was purified by crystallization using THF-water mixture.

General procedure for the preparation of 2-amino-1,3-selenazole derivatives of Fmoc/Boc/Z-amino acids
To a solution containing 10 mmol of *N*$^{\alpha}$-urethane protected amino acid derived bromomethyl ketone was added selenourea dissolved in acetone and the reaction mixture was subjected to sonication for 10 min. After the complete disappearance of the reactant (as monitored by TLC), the solvent was evaporated *in vacuo* and the residue was dissolved in THF. To this, 10 mmol (1.7 mL) of triethylamine was added and the resulting HBr salt of triethylamine was filtered. The filtrate was evaporated under vacuum and the residue was purified by column chromatography using $CHCl_3$/MeOH (9:1) system.

The characterization data for *N*-protected bromomethyl ketones

(9*H*-Fluoren-9-yl)methyl 1-(benzyloxy)-4-bromo-3-oxobutan-2-ylcarbamate (3e). Yield 85%; colorless solid; mp 112-114 ºC; R_f 0.3 (EtOAc/Hexane, 3:7); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 3.52-3.56 (m, 1H), 3.71 (m, 1H), 4.47 (t, J = 4.2 Hz, 1H), 4.52 (s, 2H) 4.69 (m, 1H), 4.73 (d, J = 5.2 Hz, 2H), 4.76 (s, 2H), 6.61 (br, 1H), 7.27–7.80 (m, 13H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 34.8, 47.2, 63.6, 66.7, 67.8, 74.9, 126.7, 127.0, 127.3, 128.1, 128.6, 128.9, 129.0, 137.2, 141.2, 143.7, 157.0, 206.9; HRMS Calcd for $C_{26}H_{24}BrNO_4$ *m/z*: 516.0786 (M^++Na), found 516.0791.

(9*H*-Fluoren-9-yl)methyl 7-benzyloxycarbonylamino-1-bromo-2-oxoheptan-3-ylcarbamate (3f). Yield 86%; colorless solid; mp 127-129 ºC; R_f 0.4 (EtOAc/Hexane, 3:7); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.21 (m, 2H), 1.33-1.37 (m, 4H), 2.93-3.04 (t, J = 4.6 Hz, 2H), 4.18 (m, 1H), 4.21 (s, 2H), 4.26 (t, J = 5.6 Hz, 1H), 4.72 (d, J = 4.8 Hz, 2H,), 5.36 (s, 2H), 6.23 (br, 2H), 7.31-7.80 (m, 13H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 21.3, 28.5, 29.8, 35.1, 41.8, 47.2, 63.2, 66.2, 67.5, 126.3, 126.9, 127.2, 128.1, 128.6, 129.0, 129.3, 141.2, 141.6, 143.6, 156.3, 157.7, 206.8; HRMS Calcd for $C_{30}H_{31}BrN_2O_5$ *m/z*: 601.1314 (M^++Na), found 601.1318.

***tert*-Butyl 7-benzyloxycarbonylamino-1-bromo-2-oxoheptan-3-ylcarbamate (3k).** Yield 86%; colorless solid; mp 93-95 ºC; R_f 0.4 (EtOAc/Hexane, 3:7); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.15 (m, 2H), 1.30 (s, 9H), 1.32-1.40 (m, 4H), 2.92-3.09 (t, J = 4.5 Hz, 2H), 4.21 (m, 1H), 4.51 (s, 2H), 5.21 (s, 2H), 6.22 (br, 2H), 7.31-7.81 (m, 5H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 21.3, 28.4, 28.6, 29.1, 34.8, 42.0, 62.3, 65.8, 80.0, 127.2, 127.8, 129.0, 141.3, 156.2, 206.1; HRMS Calcd for $C_{20}H_{29}BrN_2O_5$ *m/z*: 479.1158 (M^++Na), found 479.1154.

The characterization data for the rest of the bromoketone molecules used in this study have been previously reported (see references 31 and 32). However the physical data are furnished below:

3a. Yield 91%: colorless solid: mp 106-108 ºC;
3b. Yield 93%: colorless solid: mp 120-122 ºC;
3c. Yield 94%: colorless solid: mp 131-133 ºC;
3d. Yield 90%: colorless solid: mp 109-111 ºC;
3g. Yield 90%: colorless solid: mp 65-67 ºC;
3h. Yield 74%: colorless solid: mp 78-80 ºC;
3i. Yield 87%: colorless solid: mp 95-97 ºC;
3j. Yield 89%: gum.

Characterization data for 2-amino-1,3-selenazole derivatives of *N*$^{\alpha}$-urethane protected amino acids and heteroalanine derivatives

(9*H*-Fluoren-9-yl)methyl 1-(2-amino-1,3-selenazol-4-yl)ethylcarbamate (**4a).** Yield 89%; brownish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.42 (d, J = 4.2 Hz 3H), 4.23 (m, 1H), 4.45 (t, J = 4.1 Hz, 1H), 4.80 (d, J = 5.3 Hz, 2H), 5.81-5.85 (br, 2H), 6.72 (br, 1H), 7.21 (s, ^2J(Se-H) = 42.1 Hz, 1H), 7.32-7.76 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 17.3, 45.2, 56.7, 67.5, 108.2, 126.8, 127.3, 128.6, 128.9, 141.2, 143.8, 149.3, 156.5, 170.2; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 209.0; HRMS Calcd for $C_{20}H_{19}N_3O_2Se$ *m/z*: 436.0540 (M^++Na), found 436.0543.

(9*H*-Fluoren-9-yl)methyl 1-(2-amino-1,3-selenazol-4-yl)-2-phenylethylcarbamate (4b). Yield 90%; brownish gum; R_f 0.5 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.70-2.76 (d, *J* = 4.8 Hz, 2H), 4.42 (t, *J* = 5.0 Hz, 1H), 4.60 (m, 1H), 4.72 (d, *J* = 6.1 Hz, 2H), 5.63-5.67 (br, 2H), 6.76 (br, 1H), 7.24 (s, ^2J(Se-H) = 43.3 Hz, 1H), 7.31-7.79 (m, 13H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 31.3, 46.5, 54.4, 67.4, 110.7, 126.8, 127.2, 128.2, 128.9, 129.1, 129.8, 130.0, 138.2, 140.2, 143.4, 152.1, 157.0, 171.4; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 210.0; HRMS Calcd for $C_{26}H_{23}N_3O_2Se$ *m/z*: 512.0853 (M^++Na), found 512.0851.

(9*H*-Fluoren-9-yl)methyl 1-(2-amino-1,3-selenazol-4-yl)-2-methylpropylcarbamate (4c). Yield 88%; yellowish gum; R_f 0.6 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 0.92 (m, 6H), 2.30 (m, 1H), 4.20 (m, 1H), 4.30 (t, *J* = 5.4 Hz, 1H), 4.80 (d, *J* = 5.4 Hz, 2H), 5.87-5.91 (br, 2H), 6.02 (br, 1H), 7.25 (s, ^2J(Se-H) = 43.8 Hz, 1H), 7.32-7.80 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 18.3, 31.4, 48.2, 60.1, 67.4, 108.2, 126.3, 127.8, 128.4, 129.3, 141.2, 143.6, 151.2, 157.3, 170.2; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): 199.0; HRMS Calcd for $C_{22}H_{23}N_3O_2Se$ *m/z*: 464.0853 (M^++Na), found 464.0858.

(9*H*-Fluoren-9-yl)methyl 1-(2-amino-1,3-selenazol-4-yl)-3-methylbutylcarbamate (4d). Yield 85%; brownish gum; R_f 0.5 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 0.98 (m, 6H), 1.60 (t, *J* = 4.5 Hz, 2H), 2.21 (m, 1H), 4.42 (m, 1H), 4.51 (t, *J* = 4.8 Hz, 1H), 4.85 (d, *J* = 4.6 Hz, 2H), 6.01-6.05 (br, 2H), 6.50 (br, 1H), 7.21 (s, ^2J(Se-H) = 45.1 Hz, 1H), 7.30-7.79 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 20.3, 23.2, 45.2, 48.0, 54.2, 67.4, 109.0, 126.4, 127.3, 128.5, 129.1, 141.3, 143.8, 152.3, 156.2, 170.1; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 206.0; HRMS Calcd for $C_{23}H_{25}N_3O_2Se$ *m/z*: 478.1010 (M^++Na), found 478.1014.

(9*H*-Fluoren-9-yl)methyl 1-(2-amino-1,3-selenazol-4-yl)-2-(benzyloxy)ethylcarbamate (4e). Yield 82%; yellowish gum; R_f 0.3 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 3.51-3.58 (m, 1H), 3.64 (m, 1H), 4.46 (t, *J* = 4.3 Hz, 1H), 4.68 (m, 1H), 4.70 (d, *J* = 5.2 Hz, 2H), 4.75 (s, 2H), 6.05-6.11 (br, 2H), 6.65 (br, 1H), 7.18 (s, ^2J(Se-H) = 45.4 Hz, 1H), 7.26–7.79 (m, 13H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 46.5, 55.4, 66.4, 72.9, 80.2, 106.1, 126.8, 127.3, 128.3, 128.7, 129.0, 129.6, 130.2, 139.2, 141.6, 144.8, 145.5, 156.8, 171.1; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 205.0; HRMS Calcd for $C_{27}H_{25}N_3O_2Se$ *m/z*: 542.0959 (M^++Na), found 542.0950.

(9*H*-Fluoren-9-yl)methyl 5-(benzyloxycarbonylamino)-1-(2-amino-1,3-selenazol-4-yl) pentylcarbamate (4f). Yield 83%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.12 (m, 2H), 1.31-1.36 (m, 4H), 2.93-3.02 (t, *J* = 4.6 Hz, 2H), 4.17 (m, 1H), 4.24 (t, *J* = 5.2 Hz, 1H), 4.70 (d, *J* = 4.7 Hz, 2H,), 4.95 (s, 2H), 5.90-5.96 (br, 2H), 6.21 (br, 2H), 7.16 (s, ^2J(Se-H) = 46.5 Hz, 1H), 7.28-7.79 (m, 13H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 21.0, 29.9, 30.0, 41.2, 47.7, 55.3, 66.1, 67.0, 105.1, 126.0, 126.8, 127.9, 128.6, 129.1, 129.5, 130.3, 141.2, 141.6, 143.2, 155.0, 156.1, 156.6, 170.8; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 210.0; HRMS Calcd for $C_{31}H_{32}N_4O_4Se$ *m/z*: 627.1486 (M^++Na), found 627.1480.

Benzyl (2-amino-1,3-selenazol-4-yl)methylcarbamate (4g). Yield 80%; yellowish gum; R_f 0.3 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 4.30 (m, 2H), 4.80 (s, 2H), 5.60-5.65 (br, 2H), 6.04 (br, 1H), 6.95 (m, 5H), 7.32 (s, ^2J(Se-H) = 42.8 Hz, 1H) ; ^{13}C NMR ($CDCl_3$, 100 MHz): δ 53.0, 67.4, 105.2, 126.8, 127.6, 127.9, 141.2, 148.0, 157.2, 176.4; ^{77}Se NMR

($Me_2Se/CDCl_3$, 76 MHz): δ 202.0; HRMS Calcd for $C_{12}H_{13}N_3O_2Se$ *m/z*: 334.0071 (M^++Na), found 334.0075.

Benzyl 1-(2-amino-1,3-selenazol-4-yl)ethylcarbamate (4h). Yield 87%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.66 (d, J = 4.6 Hz, 3H), 4.20 (m, 1H), 4.65 (s, 2H), 5.62-5.67 (br, 2H), 6.08 (br, 1H,) 6.92-7.20 (m, 5H), 7.33 (s, ^2J(Se-H) = 45.4 Hz, 1H) ; ^{13}C NMR ($CDCl_3$, 100 MHz): δ 14.1, 51.5, 67.3, 110.3, 132.3, 133.2, 133.7, 142.0, 158.9, 161.0, 174.4; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 201.0; HRMS Calcd for $C_{13}H_{15}N_3O_2Se$ *m/z*: 348.0227 (M^++Na), found 348.0228.

Benzyl 1-(2-amino-1,3-selenazol-4-yl)-2-phenylethylcarbamate (4i). Yield 84%; brownish gum; R_f 0.5 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.68-2.80 (d, J = 6.8 Hz, 2H), 4.45 (t, J = 4.9 Hz, 1H), 4.68 (s, 2H), 5.61-5.68 (br, 2H), 6.10 (br, 1H), 6.95-7.10 (m, 10H), 7.25 (s, ^2J(Se-H) = 43.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 36.8, 54.2, 58.9, 109.0, 126.2, 127.2, 127.3, 128.7, 129.5, 130.2, 138.3, 142.4, 148.1, 157.1, 171.2; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 212.0; HRMS Calcd for $C_{19}H_{19}N_3O_2Se$ *m/z*: 424.0540 (M^++Na), found 424.0542.

***tert*-Butyl 1-(2-amino-1,3-selenazol-4-yl)-2-methylpropylcarbamate (4j).** Yield 81%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 0.95 (d, J = 4.52 Hz, 6H) 1.34 (s, 9H), 1.95 (m, 1H), 4.23 (m, 1H), 5.60-5.69 (br, 2H), 6.80 (br, 1H), 7.47 (s, ^2J(Se-H) = 45.1 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 18.8, 29.1, 32.6, 58.4, 78.4, 105.2, 153.0, 156.1, 170.6; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 205.0; HRMS Calcd for $C_{12}H_{21}N_3O_2Se$ *m/z*: 342.0697 (M^++Na), found 342.0692.

***tert*-Butyl 5-(benzyloxycarbonylamino)-1-(2-amino-1,3-selenazol-4-yl)pentylcarbamate (4k).** Yield 82%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.13 (m, 2H), 1.31-1.39 (m, 4H), 1.36 (s, 9H), 2.93-3.08 (t, J = 4.4 Hz, 2H), 4.19 (m, 1H), 5.20 (s, 2H), 5.59-5.66 (br, 2H), 6.70 (br, 2H), 7.28-7.74 (m, 5H), 7.24 (s, ^2J(Se-H) = 45.3 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 20.8, 28.6, 30.9, 31.0, 42.0, 59.0, 65.9, 79.3, 106.2, 126.3, 127.4, 128.5, 141.28, 154.2, 155.4, 156.2, 170.2; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 212.0; HRMS Calcd for $C_{21}H_{30}N_4O_4Se$ *m/z*: 505.1330 (M^++Na), found 505.1331.

(9*H*-Fluoren-9-yl)methyl 4-[(2-amino-1,3-selenazol-4-yl)methyl]-5-oxooxazolidine-3-carboxylate (7a). Yield 80%; brownish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.80 (m, 1H), 2.91 (m, 1H), 4.26 (m, 1H), 4.80 (t, J = 5.1 Hz, 1H), 5.01 (d, J = 5.6 Hz, 2H), 5.63-5.68 (br, 2H), 5.76 (s, 2H), 7.23 (s, ^2J(Se-H) = 45.7 Hz, 1H), 7.30-7.79 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 39.2, 47.0, 54.3, 67.2, 78.4, 106.3, 126.2, 127.3, 127.6, 128.1, 141.2, 143.7, 153.1, 154.2, 170.2, 174.32; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 201.0; HRMS Calcd for $C_{22}H_{19}N_3O_4Se$ *m/z*: 492.0438 (M^++Na), found 492.0432.

(9*H*-Fluoren-9-yl)methyl 4-[2-(2-amino-1,3-selenazol-4-yl)ethyl]-5-oxooxazolidine-3-carboxylate (7b). Yield 81%; brownish gum; R_f 0.5 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.73 (m, 2H), 2.83 (m, 2H), 4.20 (t, J = 4.4 Hz, 1H), 4.50 (t, J = 5.2 Hz, 1H), 4.72 (m, 2H), 5.64-5.71 (br, 2H), 5.75 (s, 2H), 7.15 (s, ^2J(Se-H) = 45.1 Hz, 1H), 7.23-7.70 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 23.2, 39.3, 48.1, 67.2, 74.2, 79.0, 105.2, 126.3, 127.6, 127.9, 128.3,

141.0, 143.6, 153.2, 154.2, 170.1, 174.9; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 214.00; HRMS Calcd for $C_{23}H_{21}N_3O_4Se$ *m/z*: 506.0595 (M^++Na), found 506.0590.

Benzyl 4-[(2-amino-1,3-selenazol-4-yl)methyl]-5-oxooxazolidine-3-carboxylate (7c). Yield 84%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.84 (m, 1H), 2.98 (m, 1H), 3.99 (m, 1H), 5.07 (s, 2H), 5.64-5.69 (br, 2H), 6.02 (s, 2H), 7.11 (s, ^2J(Se-H) = 43.22 Hz, 1H), 7.22-7.46 (m, 5H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 40.4, 51.9, 68.7, 78.1, 105.2, 127.6, 127.9, 128.6, 141.2, 153.3, 157.1, 172.2, 174.5; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 215.0; HRMS Calcd for $C_{15}H_{15}N_3O_4Se$ *m/z*: 404.0125 (M^++Na), found 404.0128

Benzyl 4-[2-(2-amino-1,3-selenazol-4-yl)ethyl]-5-oxooxazolidine-3-carboxylate (7d). Yield 82%; brownish gum; R_f 0.5 ($CHCl_3$/MeOH, 9:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.30 (m, 4H), 4.23 (t, *J* = 4.6 Hz, 1H), 5.23 (s, 2H), 5.58 (s, 2H), 5.75-5.81 (br, 2H), 7.20-7.34 (m, 5H) 7.41 (s, ^2J(Se-H) = 43.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 24.2, 40.2, 65.8, 74.2, 79.3, 106.2, 127.2, 127.9, 128.2, 141.2, 153.2, 154.8, 170.2, 174.9; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 213.0; HRMS Calcd for $C_{16}H_{17}N_3O_4Se$ *m/z*: 418.0282 (M^++Na), found 418.0286.

2-{[(9*H*-Fluoren-9-yl)methoxy]carbonyl}-3-(2-amino-1,3-selenazol-4-yl)propanoic acid (8a). Yield 80%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.81 (m, 1H), 2.93 (m, 1H), 4.22 (m, 1H), 4.51 (t, *J* = 4.4 Hz, 1H), 4.82 (m, 2H), 5.70-5.74 (br, 2H), 6.63 (br, 1H), 7.12 (s, ^2J(Se-H) = 44.2 Hz, 1H), 7.21-7.77 (m, 8H), 10.90 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 40.2, 47.1, 52.4, 67.5, 105.2, 126.1, 127.3, 127.5, 128.1, 141.1, 143.2, 153.1, 156.0, 171.1, 174.9; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 203.0; HRMS Calcd for $C_{21}H_{19}N_3O_4Se$ *m/z*: 480.0438 (M^++Na), found 480.0439.

2-{[(9*H*-Fluoren-9-yl)methoxy]carbonyl}-4-(2-amino-1,3-selenazol-4-yl)butanoic acid (8b). Yield 82%; yellowish gum; R_f 0.3 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.55 (m, 2H), 2.63 (m, 2H), 4.22 (t, *J* = 4.6 Hz, 1H), 4.52 (t, *J* = 5.7 Hz, 1H), 4.77 (m, 2H), 5.64-5.69 (br, 2H), 6.01 (br, 1H), 7.14 (s, ^2J(Se-H) = 42.4 Hz, 1H), 7.23-7.79 (m, 8H), 11.00 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 24.5, 38.2, 47.9, 56.8, 67.4, 105.6, 126.2, 127.3, 127.8, 128.2, 141.1, 143.7, 153.2, 156.2, 170.2, 179.2; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 204.0; HRMS Calcd for $C_{22}H_{21}N_3O_4Se$ *m/z*: 495.0595 (M^++Na), found 495.0597.

3-(2-Amino-1,3-selenazol-4-yl)-2-(benzyloxycarbonyl)propanoic acid (8c). Yield 83%; brownish gum; R_f 0.4 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.42 (m, 1H), 2.66 (m, 1H), 4.50 (m, 1H), 4.92 (s, 2H), 5.68-5.97 (br, 2H), 6.22 (br, 1H), 7.21-7.31 (m, 5H), 7.36 (s, ^2J(Se-H) = 45.5 Hz, 1H), 11.88 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 41.3, 52.1, 66.2, 105.8, 127.3, 128.3, 129.1, 141.3, 152.2, 156.2, 171.2, 174.2; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 212.0; HRMS Calcd for $C_{14}H_{15}N_3O_4Se$ *m/z*: 392.0125 (M^++Na), found 392.0127.

4-(2-Amino-1,3-selenazol-4-yl)-2-(benzyloxycarbonyl)butanoic acid (8d). Yield 84%; yellowish gum; R_f 0.3 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 2.21 (m, 2H), 2.28 (m, 2H), 4.50 (m, 1H), 5.10 (s, 2H), 6.01 (br, 2H), 6.42 (br,1H), 7.10 (s, ^2J(Se-H) = 43.8 Hz, 1H), 7.22-7.33 (m, 5H), 10.98 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 26.3, 40.2, 54.2, 66.1, 105.9, 127.2, 128.4, 129.2, 141.2, 153.3, 156.9, 170.8, 174.9; ^{77}Se NMR

($Me_2Se/CDCl_3$, 76 MHz): δ 213.0; HRMS Calcd for $C_{15}H_{17}N_3O_4Se$ *m/z*: 406.0282 (M^++Na), found 406.0285

2-{[(9*H*-Fluoren-9-yl)methoxy]carbonyl}-3-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]-propanoic acid (9a). Yield 82%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.32 (s, 9H), 2.83 (m, 1H), 3.02 (m, 1H), 4.22 (m, 1H), 4.41 (t, *J* = 5.7 Hz, 1H), 4.73 (m, 2H), 6.63-6.70 (br, 2H), 7.21 (s, ^2J(Se-H) = 44.1Hz, 1H), 7.31-7.72 (m, 8H), 10.99 (br,1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 27.3, 41.2, 48.1, 51.4, 67.5, 80.2, 106.2, 126.2, 127.4, 127.6, 128.2, 141.1, 143.2, 153.2, 153.8, 156.3, 171.3, 174.9; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 208.0; HRMS Calcd for $C_{26}H_{27}N_3O_6Se$ *m/z*: 580.0963 (M^++Na), found 580.0960.

2-{[(9*H*-Fluoren-9-yl)methoxy]carbonyl}-4-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl] butanoic acid (9b). Yield 84%; brownish gum; R_f 0.5 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.30 (s, 9H), 2.45 (m, 2H), 2.53 (m, 2H), 4.32 (m, 1H), 4.52-4.78 (m, 3H), 6.01 (br, 2H), 7.11 (s, ^2J(Se-H) = 42.9 Hz, 1H), 7.22-7.80 (m, 8H), 11.00 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 24.5, 28.5, 38.2, 47.9, 56.8, 67.4, 79.3, 105.6, 126.2, 127.3, 127.8, 128.2, 141.1, 143.7, 153.2, 154.4, 156.2, 170.2, 174.2; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 205; HRMS Calcd for $C_{27}H_{29}N_3O_6Se$ *m/z*: 594.1119 (M^++Na), found 594.1114.

2-(Benzyloxycarbonyl)-3-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]propanoic acid (9c). Yield 83%; yellowish gum; R_f 0.4 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.31 (s, 9H), 2.32 (m, 1H), 2.67 (m, 1H), 4.54 (m, 1H), 4.92 (s, 2H), 6.02 (br, 2H), 7.21-7.31 (m, 5H), 7.38 (s, ^2J(Se-H) = 45.5 Hz, 1H), 11.78 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 28.3, 41.3, 52.1, 65.2, 81.2, 105.5, 127.1, 128.5, 129.5, 139.2, 152.5, 153.7, 156.7, 171.2, 174.4; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 213.0; HRMS Calcd for $C_{19}H_{23}N_3O_6Se$ *m/z*: 492.0650 (M^++Na), found 492.0653.

2-(Benzyloxycarbonyl)-4-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]butanoic acid (9d). Yield 86%; brownish gum; R_f 0.3 ($CHCl_3$/MeOH/AcOH, 40:2:1); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.30 (s, 9H), 2.25 (m, 2H), 2.38 (m, 2H), 4.55 (m, 1H), 5.14 (s, 2H), 6.02 (br, 2H), 7.01 (s, ^2J(Se-H) = 44.4 Hz, 1H), 7.12-7.82 (m, 5H), 11.20 (br, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 26.5, 28.3, 41.2, 54.4, 66.4, 80.6, 105.9, 127.4, 128.2, 129.4, 141.1, 153.3, 154.4, 156.9, 170.9, 174.9; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 211.0; HRMS Calcd for $C_{20}H_{25}N_3O_6Se$ *m/z*: 506.0806 (M^++Na), found 506.0808.

Methyl 2-(2-{[(9*H*-fluoren-9-yl)methoxy]carbonyl}-3-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]propanamido)acetate (10a). Yield 81%; brownish gum; R_f 0.4 ($CHCl_3$/MeOH, 95:5); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.38 (s, 9H), 2.82 (m, 1H), 2.93 (m, 1H), 3.12-3.25 (s, 3H), 4.23 (m, 2H), 4.46-4.52 (m, 3H), 4.72 (t, *J* = 5.2 Hz, 1H), 6.12-6.25 (br, 3H), 7.10 (s, ^2J(Se-H) = 42.2 Hz, 1H), 7.22-7.92 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 28.1, 40.5, 42.1, 47.3, 51.3, 52.5, 67.5, 80.5, 105.5, 126.7, 127.3, 128.2, 128.9, 141.6, 143.5, 152.0, 153.3, 156.0, 169.3, 170.1, 172.2; ^{77}Se NMR ($Me_2Se/CDCl_3$, 76 MHz): δ 214.0; HRMS Calcd for $C_{29}H_{32}N_4O_7Se$ *m/z*: 651.1334 (M^++Na), found 651.1332.

Methyl 2-(2-{[(9*H*-fluoren-9-yl)methoxy]carbonyl}-4-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]butanamido)propanoate (10b). Yield 83%; yellowish gum; R_f 0.5 ($CHCl_3$/MeOH, 95:5); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.41 (s, 9H), 1.44 (d, J = 5.5 Hz, 3H), 1.80 (m, 2H), 1.91 (m, 2H), 3.61 (s, 3H), 4.46-4.62 (m, 3H), 4.73 (d, J = 6.5 Hz, 2H), 6.20-6.32 (br, 3H), 7.14 (s, ^2J(Se-H) = 42.4 Hz, 1H), 7.23-7.72 (m, 8H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 17.4, 27.3, 28.4, 37.8, 47.2, 48.4, 52.0, 56.1, 68.2, 79.6, 106.1, 126.8, 127.5, 128.3, 128.6, 141.7, 143.8, 152.1, 153.6, 157.0, 169.5, 170.2, 172.3,; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 216.0; HRMS Calcd for $C_{31}H_{36}N_4O_7Se$ *m/z*: 679.1647 (M^++Na), found 679.1648.

Methyl 2-[2-(benzyloxycarbonyl)-3-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]propanamido]-3-phenylpropanoate (10c). Yield 88%; Yellowish gum; R_f 0.4 ($CHCl_3$/MeOH, 95:5); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 1.42 (s, 9H), 2.65 (m, 2H), 3.22 (m, 2H), 3.72 (s, 3H), 4.59 (m, 1H), 4.90 (m, 1H), 5.42 (s, 2H), 6.42-6.55 (br, 3H), 7.12-7.26 (m, 10H), 7.36 (s, ^2J(Se-H) = 44.6 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 29.0, 38.2, 43.1, 51.7, 52.2, 66.2, 80.1, 106.1, 126.2, 126.9, 127.0, 127.2, 127.3, 128.0, 136.6, 138.1, 140.1, 141.2, 150.4, 152.3, 153.2, 156.8, 170.2, 171.2, 171.8; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 217.0; HRMS Calcd for $C_{29}H_{34}N_4O_7Se$ *m/z*: 653.1493 (M^++Na), found 653.1490.

Methyl 2-[2-(benzyloxycarbonyl)-4-[2-(*tert*-butoxycarbonyl)-1,3-selenazol-4-yl]butanamido]-3-methylbutanoate (10d). Yield 86%; brownish gum; R_f 0.4 ($CHCl_3$/MeOH, 95:5); ^{1}H NMR ($CDCl_3$, 400 MHz): δ 0.96 (d, J = 6.4 Hz, 6H), 1.39 (s, 9H), 1.86 (m, 2H), 1.92 (m, 2H), 3.24 (m, 1H), 3.46 (s, 3H), 4.32 (m, 1H), 4.62 (m, 1H), 5.52 (s, 2H), 6.25-6.38 (br, 3H), 7.12-7.33 (m, 5H), 7.44 (s, ^2J(Se-H) = 45.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz): δ 17.6, 27.2, 28.8, 31.2, 38.3, 52.0, 55.1, 56.0, 66.2, 80.2, 106.2, 126.2, 127.8, 129.1, 138.2, 153.0, 154.0, 156.3, 170.0, 171.2, 172.2; ^{77}Se NMR (Me_2Se/$CDCl_3$, 76 MHz): δ 214.0; HRMS Calcd for $C_{26}H_{36}N_4O_7Se$ *m/z*: 619.1647 (M^++Na), found 619.1644.

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