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Synthesis of γ-Oxo-α-amino Acids via Radical Acylation with Carboxylic Acids

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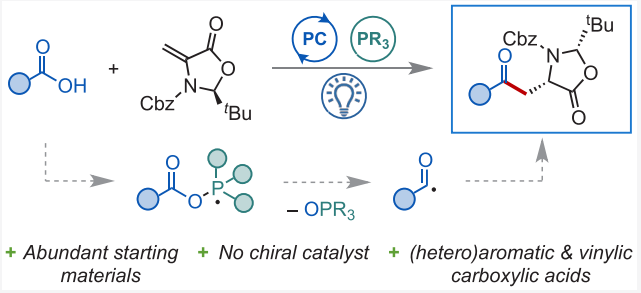
ABSTRACT: Herein we present a highly efficient, light-mediated, deoxygenative protocol to access γ-oxo-α-amino acid derivatives. This radical methodology employs photoredox catalysis, in combination with triphenylphosphine, to generate acyl radicals from readily available (hetero)aromatic and vinylic carboxylic acids. This approach allows for the straightforward synthesis of γ-oxo-α-amino acids bearing a wide range of functional groups (e.g., Cl, CN, furan, thiophene, Bpin) in synthetically useful yields (~60% average yield). To further highlight the utility of the methodology, several deprotection and derivatization reactions were carried out.



γ-Oxo-α-amino acids are highly versatile building blocks in organic synthesis, as well as key components in biologically active molecules. They can be used as precursors for homophenylalanine derivatives,[1] γ-hydroxy-α-amino acids,[2] γ-valerolactones,[3] or γ-valerolactames, for example. As it is often the case in synthetic chemistry, one of the main challenges associated with this interesting class of amino acids is their stereoselective synthesis. There are four main retrosynthetic pathways to achieve this goal: (a) via acylation reactions, starting from L- or D-aspartic acid,[4] (b) via asymmetric or diastereoselective Mannich reactions,[5] (c) via asymmetric Stetter reactions,[6] or (d) via transition metal-mediated cross-couplings with iodoalanine or β-metalated alanine derivatives (Figure 1A).[7] While powerful, these methodologies often present limitations regarding the scope of coupling partners, or require the use of chiral catalysts.

Radical chemistry offers exciting and highly attractive approaches to access new chemical space in a rapid fashion.[8] As such, it has been exploited for the synthesis and derivatization of amino acids and peptides.[9] We recently contributed to this area with the development of a decarboxylative protocol for the diastereoselective synthesis of a wide range of unnatural amino acids (UAAs) using the Beckwith−Karady alkene **I**[10] as radical acceptor.[11] Although this methodology granted access to γ-oxo-α-amino acids derivatives (**II**) when using α-keto acids as acylating reagents (Figure 1B), it afforded diminished yields with electron deficient or (hetero)aromatic systems. In addition, α-keto acids are not readily available, and their synthesis often requires the use of hazardous reagents, such SeO_2. Since **II** is a highly versatile species, we became interested in developing alternative methodologies for its synthesis using more readily available starting materials.[12]

Recently, the development of deoxygenative radical strategies to access acyl radicals has attracted increased attention.[13] Seminal independent studies by Rovis and Doyle[13e] and Zhu[13d] described the use of photoredox catalysis to generate phosphine radical cations that swiftly react with carboxylates to generate acyl radicals and phosphine oxide after β-scission (vide infra).[14] Encouraged by these reports, we envisioned that it might be possible to develop a diastereoselective synthesis of γ-oxo-α-amino acids using **I** and readily available carboxylic acids as acyl radical sources (Figure 1C).

Herein we present a highly efficient, light-mediated deoxygenative protocol to access products **II** from readily and commercially available (hetero)aromatic and vinylic carboxylic acids. In addition, the utility of this methodology is further highlighted by several derivatizations and deprotections of **II**.[15]

Initial optimization studies were carried out using benzoic acid as the acylating reagent.[16] The targeted product (**1**) could be isolated in 95% yield and excellent diastereoselectivity (d.r. > 20:1) using 1.0 equiv of **I**, 1.5 equiv of benzoic acid, 1.8 equiv. of PPh_3, 2.0 equiv. of 2,4,6-collidine, and 1.0 mol% $[Ir(dFCF_3ppy)_2(dtbbpy)][PF_6]$ (**Ir−F**) in 1,4-dioxane (0.2 M) while irradiating with 32 W blue LEDs (λ_{max} = 440 nm) for 24 h at room temperature. Control experiments showed that the reaction needs both light and a photocatalyst to proceed, and that it does not proceed when using 4CzIPN,[17] an

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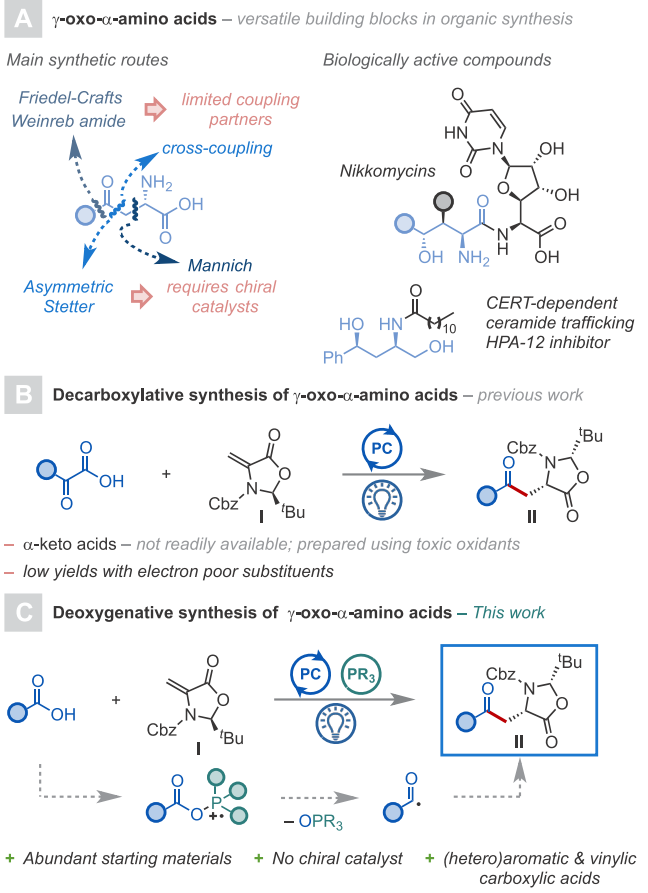

Figure 1. Synthetic strategies toward γ-oxo-α-amino acids.

organophotocatalyst possessing similar redox potentials to **Ir–F**.

With the optimized conditions in hand, the scope and limitations, as well as the scalability of the methodology, were explored (Scheme 1). The standard reaction with benzoic acid was scaled up to 5.0 mmol (1.4 g of **II**), affording **1** in 95% (1.9 g) and 73% (1.4 g) yield using 0.5 mol% and 0.25 mol% of **Ir–F**, respectively. This highlights the high catalytic efficiency of the methodology, affording TON up to 288. Regarding the scope, aromatic carboxylic acids were first tested (**2–15**). Both electron rich and poor *para*-substituents on the aromatic ring were tolerated (**2–10**), although the latter afforded diminished yields. However, this represents a significant improvement compared to our previous methodology employing α-keto acids as acylating reagents, e.g., compound **9** was isolated in 61% yield vs 31% yield using α-keto acids.[11] Free nucleophilic motifs, such as hydroxy groups, were not tolerated (**2**); however, this limitation could be circumvented by the use of protecting groups (**3** and **4**). Challenging substrates bearing sensitive functional groups, such as nitriles (**8**) or aldehydes (**10**), afforded the desired products in moderate to poor yields, while compound **15**, bearing a *meta*-boronic ester substituent, was obtained in 76% yield. Gratifyingly, *ortho*-substituents were well tolerated (**12** and **13**), and salicylic acid derived **13** was obtained in an excellent 92% yield. More complex aromatic carboxylic acids bearing multiple functional groups (**14**) afforded the targeted γ-oxo-α-amino acid derivative in excellent yield.

The use of heteroaromatic carboxylic acids was also investigated (**16–22**). While nicotinic acid afforded the desired product in moderate yields (**16**), no product was observed with picolinic or pyrazinoic acids (**18–19**). Surprisingly, when the reaction was carried out using 4-chloro-1,3-dimethylpyrazolo[3,4-*b*]pyridine-5-carboxylic acid, the main product was the dechlorinated species **17** (39%), while the expected product **17′** was isolated in 18% yield. The use of 5-membered heterocycles (**20–22**), such as unprotected pyrroles (**20**), furans (**21**), and thiophenes (**22**) afforded the desired products in variable yields (21–71%). Overall, our new methodology presents a broad functional group tolerance, where compounds bearing several vectors for further functionalization, such as halides, boronic esters, or amines, can be readily obtained.

To further challenge the limits of our methodology, the use of aliphatic, cinnamic, and vinylic carboxylic acids as acylating reagents was evaluated. While hydrocinnamic acid failed to afford the desired product,[16] cinnamic acid delivered a complex mixture, from where the targeted product could not be isolated.[18] However, the use of cyclic, vinylic carboxylic acids afforded interesting γ-oxo-α-amino acid derivatives bearing 5- and 6-membered heterocycles, such dihydrofuranes (**27**), tetrahydropyrines (**26**), and tetrahydropyrans (**24**). To the best of our knowledge, this is the first time that vinylic carboxylic acids have been directly used as acyl radical precursors.

To highlight the utility of our methodology, a series of derivatization reactions were carried out. Acidic deprotection of **II** using concentrated HCl in 1,4-dioxane afforded γ-oxo-α-amino acid salts **28–30** in quantitative yields (Scheme 2A). To check the e.r. of the products after the deprotection step, compound **1** was deprotected and further derivatized to the corresponding *N*-Boc protected methyl ester. HPLC analysis of the latter revealed a 92:8 e.r. Our methodology can also be applied for the acylation of dehydroalanine derivative **IA**, affording the corresponding product **1A** in 55% yield (Scheme 2B), and for the synthesis of ^{13}C-labeled amino acid derivatives (Scheme 2C).

Finally, a plausible reaction mechanism for this transformation is shown in Figure 2. First, the excited photocatalyst ($^*Ir^{III}$, $^*E_{1/2}$ = +1.21 V vs SCE)[19] undergoes reductive quenching by PPh_3 ($E_{1/2}$ = +0.98 V vs SCE)[20] to generate triphenylphosphine radical cation **III** and a Ir^{II} species. **III** reacts with the corresponding carboxylic acid to afford phosphoranyl radical **IV**, which readily undergoes β-scission to deliver $OPPh_3$ and the key acyl radical **V**. Subsequent radical addition of the latter to **I** affords α-amino radical **VI**, which after reduction by the reduced Ir^{II} ($E_{1/2}$ = −1.37 V vs SCE)[19] and protonation delivers the desired product **II**. This mechanism is in accordance with previous proposals for acylation reactions using photoredox catalysis to access phosphoranyl radicals.[13,14] Quantum yield determinations suggest that there is also a significant contribution from a radical-chain pathway (Φ = 13.5).[16] On the basis of further experiments, 2,4,6-collidine seems to play a crucial role in the chain process. However, at this point, the nature of the chain carrier remains elusive.[16]

In conclusion, we have developed a highly efficient, light-mediated, deoxygenative strategy for the synthesis of γ-oxo-α-amino acid derivatives. This radical methodology exploits the addition of acyl radicals, generated from readily available carboxylic acids, to Beckwith–Karady alkene **I**, allowing for the straightforward synthesis of a wide range of γ-oxo-α-amino acid derivatives in excellent diastereoselectivities and synthetically

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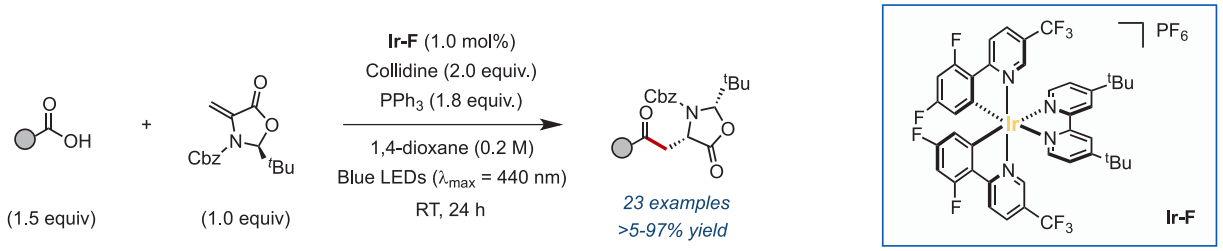
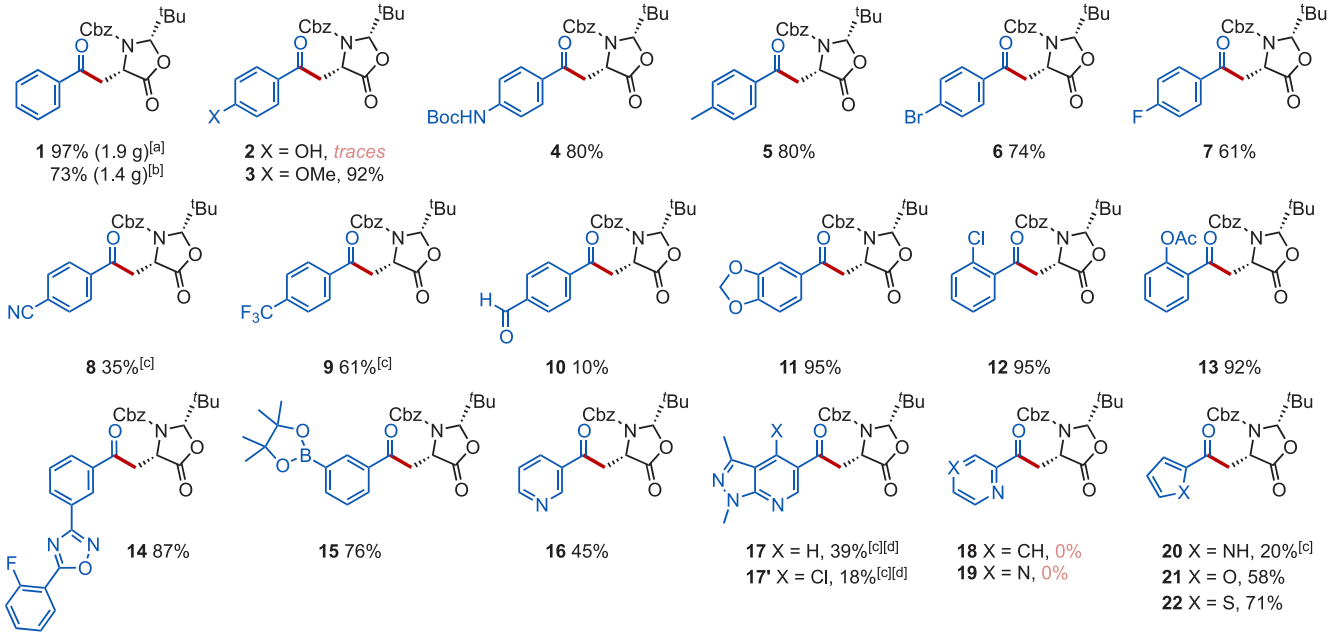
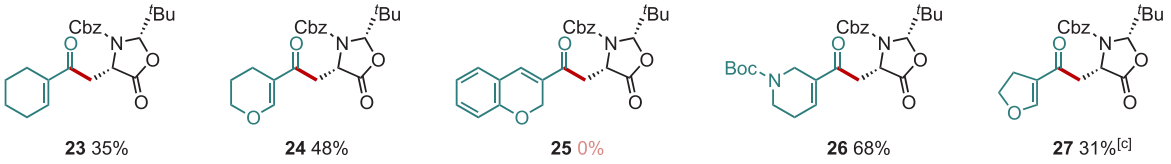
Scheme 1. Scope and Limitations of the Methodology[e]



(Hetero)aromatic carboxylic acids



Vinylic carboxylic acids



[a]5.0 mmol scale, **Ir−F** 0.5 mol%. [b]5.0 mmol scale, **Ir−F** 0.25 mol%, 72 h. [c]48 h. [d]DMF (0.2 M). [e]Reaction conditions: Acid (0.75 mmol, 1.5 equiv.), **I** (0.50 mmol, 1.0 equiv.), **Ir−F** (1.0 mol%), PPh_3 (0.9 mmol, 1.8 equiv.), 2,4,6-collidine (1.0 mmol, 2.0 equiv.), 1,4-dioxane (0.2 M), RT, 24 h; product d.r. > 20:1.

useful yields (~60% average yield). Furthermore, the synthetic utility of this protocol was highlighted by a series of derivatization reactions, granting access to in good yields and diastereoselectivities.

EXPERIMENTAL SECTION

General Information. Commercial reagents and solvents were used as purchased. Unless otherwise noted, all reactions were carried out under an atmosphere of N_2 in flame-dried glassware. The solvents used were purified by distillation over standard drying agents and were stored over molecular sieves or transferred under N_2. Blue LEDs (Kessil PR-160, 32 W, λ_{max} = 440 nm or EvoluChem CREE XPE, 30 W, λ_{max} = 450 nm) were used for irradiation, in combination with an EvoluChem PhotoRedOx Box. The reaction temperature was kept at 27 °C thanks to the fans incorporated in the reactor.

TLC were conducted with precoated glass-backed plates (silica gel 60 F254) and visualized by exposure to UV light (254 nm) or stained with ceric ammonium molybdate (CAM), basic potassium permanganate ($KMnO_4$), Ninhydrin or *p*-anisaldehyde solutions, and subsequent heating. Flash column chromatography was performed on silica gel (40−60 μm), and the eluent used is reported in the respective experiments.

^1H NMR spectra were recorded with 400 or 600 MHz instruments, $^{13}C\{^1H\}$ NMR spectra at 101 or 151 MHz. Chemical shifts are reported in ppm relative to the solvent signal, coupling constants *J* in Hz. Multiplicities were defined by standard abbreviations. Low-resolution mass spectra (LRMS) were recorded using a LC/MS-combination (ESI). High-resolution mass spectra (HRMS) were obtained using ESI ionization (positive) on a Bruker micrOTOF.

All carboxylic acids were commercially available, while [Ir(dFCF$_3$ppy)$_2$(dtbbpy)][PF$_6$] (**Ir−F**),[21] **I** and **IA** were synthesized according to literature procedures.[10c]

Synthesis and Characterization of Products. *General Procedure A (GP-A).* An 8 mL Biotage microwave vial was charged with the corresponding carboxylic acid (0.75 mmol, 1.5 equiv.), **I** (145 mg, 0.50 mmol, 1.0 equiv.), PPh_3 (235 mg, 0.9 mmol, 1.8 equiv.), **Ir−F** (5.5 mg, 5 μmol, 1 mol%), and sealed with a septum cap. The vial was put under a vacuum for 1 min and refilled with N_2 (× 3). Afterward, 2,4,6-collidine (132 μL, 1.0 mmol, 2.0 equiv.) and

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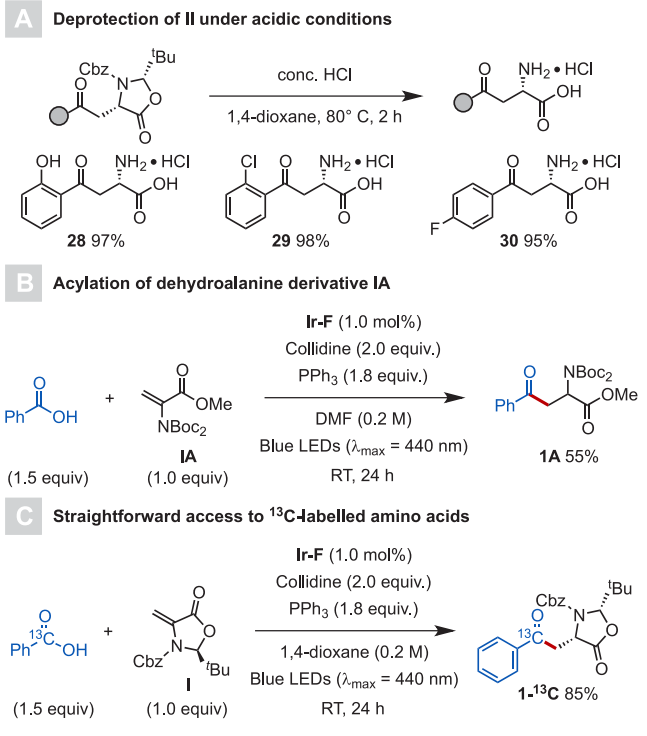
Scheme 2. Deprotection and Derivatization Reactions



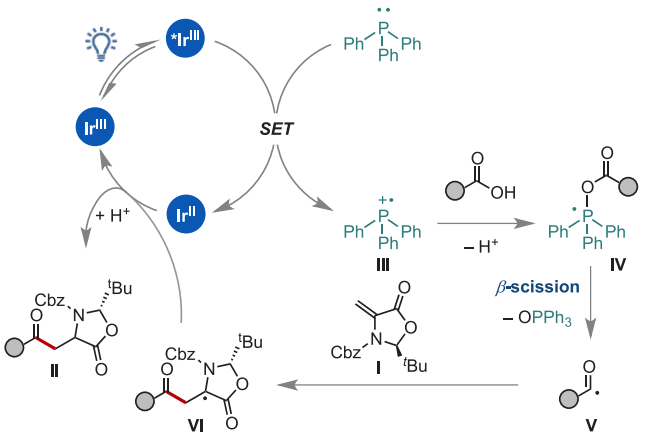


Figure 2. Plausible reaction mechanism.

degassed 1,4-dioxane (2.5 mL, 0.2 M) were added. The reaction mixture was then sparged with N_2 for 2−5 min and irradiated with blue LEDs (λ_{max} = 440 or 450 nm) in an EvoluChem PhotoRedOx Box for 24 h. Finally, the solvent was evaporated and the crude reaction mixture was purified by column chromatography over silica gel to afford the desired product.

General Procedure B (GP-B). An 8 mL Biotage microwave vial was charged with the corresponding carboxylic acid (0.75 mmol, 1.5 equiv.), **I** (145 mg, 0.50 mmol, 1.0 equiv.), PPh_3 (235 mg, 0.9 mmol, 1.8 equiv.), **Ir−F** (5.5 mg, 5 μmol, 1 mol%), and sealed with a septum cap. The vial was put under a vacuum for 1 min and refilled with N_2 (× 3). Afterward, 2,4,6-collidine (132 μL, 1.0 mmol, 2.0 equiv.) and degassed DMF (2.5 mL, 0.2 M) were added. The reaction mixture was then sparged with N_2 for 2−5 min and irradiated with blue LEDs (λ_{max} = 440 or 450 nm) in an EvoluChem PhotoRedOx Box for 24 h. Finally, the solvent was evaporated and the crude reaction mixture was purified by column chromatography over silica gel to afford the desired product.

Characterization Data. *(2S,4S)-2-(tert-Butyl)-5-oxo-4-(2-oxo-2-phenylethyl)oxazolidine-3-carboxylate (**1**).* In 0.5 mmol scale: Synthesized following **GP-A** using benzoic acid (90 mg, 0.75 mmol 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **1** as a yellow oil in 95% yield (190 mg, 0.48 mmol). The spectroscopic data are consistent with those previously reported.[11] ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94−7.88 (m, 2H), 7.62−7.55 (m, 1H), 7.49−7.42 (m, 2H), 7.32−7.27 (m, 3H), 7.24−7.20 (m, 2H), 5.61 (s, 1H), 5.24 (dd, J = 6.9, 5.0 Hz, 1H), 5.11 (d, J = 12.1 Hz, 1H), 5.00 (d, J = 12.1 Hz, 1H), 3.56 (dd, J = 16.4, 6.9 Hz, 1H), 3.38 (dd, J = 16.4, 5.0 Hz, 1H), 1.02 (s, 9H).

In 5.0 mmol scale: Synthesized following **GP-A** using benzoic acid (916 mg, 7.5 mmol 1.5 equiv.) and **Ir−F** (28 mg, 25 μmol, 0.5 mol%). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **1** as a yellow oil in 97% yield (1.9 g, 4.8 mmol).

In 5.0 mmol scale: Synthesized following **GP-A** using benzoic acid (916 mg, 7.5 mmol 1.5 equiv.) and **Ir−F** (14 mg, 12.5 μmol, 0.25 mol %) for 72 h. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **1** as a yellow oil in 73% yield (1.4 g, 3.6 mmol).

*Benzyl (2R,4R)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-phenylethyl-2-^{13}C)oxazolidine-3-carboxylate (**1-^{13}C**).* Synthesized following **GP-A** using benzoic acid-α-^{13}C (92.3 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by column chromatography (cyclohexane/:EtOAc, 4:1) to provide **1-^{13}C** as a yellow oil in 85% yield (110 mg, 0.27 mmol). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (ddd, J = 8.5, 3.8, 1.3 Hz, 2H), 7.58 (tt, J = 6.9, 1.4 Hz, 1H), 7.46 (tt, J = 7.1, 0.7 Hz, 2H), 7.31−7.27 (m, 3H), 7.25−7.19 (m, 2H), 5.61 (s, 1H), 5.24 (ddd, J = 6.9, 5.0, 3.6 Hz, 1H), 5.11 (d, J = 12.1 Hz, 1H), 5.00 (d, J = 12.0 Hz, 1H), 3.56 (ddd, J = 16.3, 6.9, 5.5 Hz, 1H), 3.38 (ddd, J = 16.3, 6.0, 5.0 Hz, 1H), 1.02 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 194.8, 172.2, 172.1, 155.7, 136.7, 136.2, 135.3, 133.6, 128.9, 128.7, 128.5, 128.4, 96.4, 68.4, 53.8, 42.3, 41.8, 37.6, 24.9. HRMS (FI) [m/z] calculated for $C_{22}{}^{13}CH_{25}NNaO_5$ ([M + Na]$^+$) 419.1664, found 419.1666.

*Methyl 2-(bis(tert-butoxycarbonyl)amino)-4-oxo-4-phenylbutanoate (**1A**).* Synthesized following **GP-B** using benzoic acid (91.5 mg, 0.75 mmol, 1.5 equiv.) and **IA** (190.1 mg, 0.50 mmol, 1.0 equiv.). The crude product was purified by column chromatography (cyclohexane/:EtOAc, 4:1) to provide **1A** as a yellow oil in 54% yield (110 mg, 0.27 mmol). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00−7.95 (m, 2H), 7.57 (s, 1H), 7.48 (dd, J = 7.3, 0.9 Hz, 2H), 5.73 (dd, J = 6.8, 5.7 Hz, 1H), 4.04 (dd, J = 17.5, 6.8 Hz, 1H), 3.72 (s, 3H), 3.28 (dd, J = 17.5, 5.7 Hz, 1H), 1.51 (s, 18H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 196.7, 170.9, 152.1, 136.8, 133.3, 128.8, 128.3, 83.5, 54.8, 52.6, 40.0, 28.2. HRMS (FI) [m/z] calculated for $C_{21}H_{29}NNaO_7$ ([M + Na]$^+$) 430.1840, found 430.1836. IR $\tilde{\nu}$ [cm^{-1}] = 2980 (s), 2935 (s), 1797 (m), 1967 (m), 1478 (m), 1451 (m), 1367 (s), 1238 (s), 1094 (m), 1045 (s), 850 (s), 766 (s), 691 (s), 634 (s), 606 (m), 440 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.62 [*p*-Anisaldehyde].

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(4-methoxyphenyl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**3**).* Synthesized following **GP-A** using 4-methoxybenzoic acid (114 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **3** as a yellow oil in 92% yield (195 mg, 0.46 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.92−7.85 (m, 2H), 7.38−7.35 (m, 1H), 7.30−7.28 (m, 2H), 7.24−7.21 (m, 2H), 6.96−6.87 (m, 2H), 5.61 (s, 1H), 5.23 (dd, J = 7.0, 5.0 Hz, 1H), 5.13−5.09 (m, 1H), 5.00 (d, J = 12.1 Hz, 1H), 3.87 (s, 3H), 3.50 (dd, J = 16.1, 7.0 Hz, 1H), 3.33 (dd, J = 16.1, 5.0 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 193.3, 172.3, 163.9, 155.7, 135.3, 130.6, 129.5, 128.7, 128.7, 128.6, 128.5, 114.1, 96.4, 68.3, 55.7, 53.9, 41.7, 37.6, 24.9. HRMS (FI) [m/z] calculated for $C_{24}H_{27}NNaO_6$ ([M + Na]$^+$) 448.1731, found 448.1734. IR $\tilde{\nu}$ [cm^{-1}] = 2964 (w), 2914 (w), 2874 (w), 2842 (w), 1792 (s), 1718 (s), 1677 (m), 1599 (s), 1575 (m), 1511 (m), 1481 (w), 1457 (m), 1393 (m), 1345 (s), 1291 (s), 1258 (s), 1238 (s), 1217 (s), 1200 (m), 1168 (s), 1118 (m), 1067 (m), 1040 (s), 1027 (s), 989 (s), 889 (m), 840 (m), 824 (m), 783 (m), 738 (m), 697 (s), 633 (m), 596 (m), 563 (m), 531

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(m), 505 (m), 454 (m). R_f (cyclohexane/EtOAc, 5:1) = 0.31 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +41.1 (ρ = 0.99, CH_2Cl_2).

*Benzyl (2S,4S)-4-(2-(4-((tert-butoxycarbonyl)amino)phenyl)-2-oxoethyl)-2-(tert-butyl)-5-oxooxazolidine-3-carboxylate (**4**).* Synthesized following **GP-A** using 4-((*tert*-butoxycarbonyl)amino)-benzoic acid (178 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **4** as a fine yellowish powder in 80% yield (203 mg, 0.40 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.92−7.85 (m, 2H), 7.38−7.35 (m, 1H), 7.30−7.28 (m, 2H), 7.26−7.20 (m, 2H), 6.96−6.87 (m, 2H), 5.61 (s, 1H), 5.23 (dd, *J* = 7.0, 5.0 Hz, 1H), 5.12−5.10 (m, 1H), 5.00 (d, *J* = 12.1 Hz, 1H), 3.87 (s, 3H), 3.50 (dd, *J* = 16.1, 7.0 Hz, 1H), 3.33 (dd, *J* = 16.1, 5.0 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 193.4, 172.2, 155.7, 152.2, 143.4, 135.3, 131.0, 129.8, 128.7, 128.6, 128.5, 117.7, 96.4, 81.5, 68.3, 53.9, 41.7, 37.6, 28.4, 24.9. HRMS (FI) [*m*/*z*] calculated for $C_{28}H_{34}N_2NaO_7$ ([M + Na]$^+$) 533.2258, found 533.2265. IR $\tilde{\nu}$ [cm^{-1}] = 3338 (w), 2972 (w), 2930 (w), 2875 (w), 2852 (w), 1792 (m), 1718 (m), 1679 (m), 1588 (m), 1525 (m), 1502 (m), 1481 (w), 1454 (w), 1393 (m), 1366 (m), 1344 (m), 1312 (m), 1290 (m), 1229 (s), 1149 (s), 1122 (m), 1045 (m), 990 (m), 900 (w), 838 (m), 822 (m), 769 (m), 747 (m), 696 (m), 626 (m), 593 (w), 576 (w), 540 (m), 510 (m), 458 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.29 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +35.6 (ρ = 1.02, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-(p-tolyl)ethyl)-oxazolidine-3-carboxylate (**5**).* Synthesized following **GP-A** using 4-methylbenzoic acid (103 mg, 0.76 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 5:1) to provide **5** as a yellow oil in 80% yield (165 mg, 0.40 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84−7.77 (m, 2H), 7.30−7.27 (m, 3H), 7.26−7.24 (m, 2H), 7.23−7.20 (m, 2H), 5.61 (s, 1H), 5.23 (dd, *J* = 6.9, 5.0 Hz, 1H), 5.11 (d, *J* = 12.1 Hz, 1H), 4.99 (d, *J* = 12.1 Hz, 1H), 3.53 (dd, *J* = 16.2, 6.9 Hz, 1H), 3.35 (dd, *J* = 16.2, 5.1 Hz, 1H), 2.42 (s, 3H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 194.4, 172.2, 155.7, 144.5, 135.3, 134.0, 129.6, 128.7, 128.6, 128.5, 128.5, 96.4, 68.3, 53.9, 41.9, 37.6, 24.9, 21.8. HRMS (FI) [*m*/*z*] calculated for $C_{24}H_{27}NNaO_5$ ([M + Na]$^+$) 432.1781, found 432.1789. IR $\tilde{\nu}$ [cm^{-1}] = 3063 (w), 3034 (w), 2966 (w), 2875 (w), 1792 (s), 1719 (s), 1682 (s), 1606 (m), 1573 (m), 1480 (w), 1453 (m), 1393 (s), 1344 (s), 1289 (s), 1235 (s), 1174 (s), 1120 (s), 1068 (m), 1041 (s), 1018 (s), 984 (s), 890 (m), 840 (m), 807 (m), 745 (s), 697 (s), 635 (w), 592 (m), 560 (m), 531 (m), 506 (m), 455 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.45 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +43.6 (ρ = 1.03, CH_2Cl_2).

*Benzyl (2S,4S)-4-(2-(4-bromophenyl)-2-oxoethyl)-2-(tert-butyl)-5-oxooxazolidine-3-carboxylate (**6**).* Synthesized following **GP-A** using 4-bromobenzoic acid (151 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 10:1) to provide **6** as a yellow oil in 74% yield (175 mg, 0.37 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.6 Hz, 2H), 7.57 (d, *J* = 8.6 Hz, 2H), 7.31 (d, *J* = 1.5 Hz, 3H), 7.24−7.17 (m, 2H), 5.61 (s, 1H), 5.18 (dd, *J* = 6.9, 5.1 Hz, 1H), 5.10 (d, *J* = 12.0 Hz, 1H), 5.01 (d, *J* = 12.0 Hz, 1H), 3.49 (dd, *J* = 16.2, 6.9 Hz, 1H), 3.33 (dd, *J* = 16.2, 5.1 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 193.9, 172.0, 155.6, 135.1, 135.1, 132.2, 129.8, 128.8, 128.8, 128.8, 128.6, 110.0, 96.5, 68.5, 53.8, 41.9, 37.6, 24.9. IR $\tilde{\nu}$ [cm^{-1}] = 2963 (w), 2874 (w), 1791 (s), 1719 (m), 1688 (m), 1584 (s), 1581 (m), 1457 (m), 1393 (m), 1343 (m), 1286 (m), 1235 (m), 1173 (m), 1120 (m), 1068 (m), 1042 (m), 989 (w), 823 (m), 733 (m), 697 (s), 509 (s), 453 (s). HRMS (ESI) [*m*/*z*] calculated for $C_{23}H_{24}BrNNaO_5$ ([M + Na]$^+$) 496.0729, found 496.0730. R_f (cyclohexane/EtOAc, 4:1) = 0.62 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +40.5 (ρ = 0.93, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(4-fluorophenyl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**7**).* Synthesized following **GP-A** using 4-fluorobenzoic acid (105 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **7** as a yellowish oil in 61% yield (127 mg, 0.31 mmol). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96−7.86 (m, 2H), 7.35−7.24 (m, 3H), 7.28−7.19 (m, 2H), 7.16−7.05 (m, 2H), 5.62 (s, 1H), 5.21 (dd, *J* = 7.0, 5.0 Hz, 1H), 5.11 (d, *J* = 12.1 Hz, 1H), 5.03 (d, *J* = 12.1 Hz, 1H), 3.51 (dd, *J* = 16.3, 7.0 Hz, 1H), 3.34 (dd, *J* = 16.2, 5.0 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 193.3, 172.1, 166.1 (d, $^1J_{C-F}$ = 255.5 Hz), 155.7, 135.2, 132.8 (d, $^4J_{C-F}$ = 3.1 Hz), 131.0 (d, $^3J_{C-F}$ = 9.3 Hz), 128.8, 128.7, 128.5, 116.1 (d, $^2J_{C-F}$ = 22.0 Hz), 96.4, 68.5, 53.8, 41.9, 37.6, 24.9. ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ −104.4. HRMS (FI) [*m*/*z*] calculated for $C_{23}H_{24}FNNaO_5$ ([M + Na]$^+$) 436.1531, found 436.1535. IR $\tilde{\nu}$ [cm^{-1}] = 3067 (w), 3035 (w), 2969 (w), 2913 (w), 2875 (w), 1791 (s), 1719 (s), 1687 (s), 1596 (s), 1507 (w), 1481 (w), 1456 (w), 1392 (m), 1345 (s), 1289 (s), 1230 (s), 1199 (s), 1178 (s), 1156 (s), 1122 (m), 1069 (m), 1042 (s), 1018 (m), 993 (m), 911 (w), 891 (w), 842 (m), 822 (m), 786 (w), 732 (m), 697 (m), 637 (w), 593 (m), 561 (w), 531 (w), 510 (w), 456 (w), 419 (w). R_f (cyclohexane/EtOAc, 4:1) = 0.43 [$KMnO_4$]. $[\alpha]_D^{20}$ = +29.5 (ρ = 1.02, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(4-cyanophenyl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**8**).* Synthesized following **GP-A** using 4-cyanobenzoic acid (111 mg, 0.75 mmol, 1.5 equiv.) and irradiating for 48 h. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **8** as an off-white solid in 35% yield (73 mg, 0.17 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.0 Hz, 2H), 7.72 (d, *J* = 8.1 Hz, 2H), 7.35−7.29 (m, 3H), 7.23 (dd, *J* = 7.2, 2.0 Hz, 2H), 5.62 (s, 1H), 5.19−5.14 (m, 1H), 5.10 (d, *J* = 11.9 Hz, 1H), 5.04 (d, *J* = 12.0 Hz, 1H), 3.52 (dd, *J* = 16.4, 7.0 Hz, 1H), 3.37 (dd, *J* = 16.3, 5.0 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 193.8, 171.8, 155.6, 139.3, 135.0, 132.7, 128.9, 128.8, 128.7, 128.6, 117.9, 116.9, 96.6, 68.6, 53.8, 42.2, 37.6, 24.9. HRMS (FI) [*m*/*z*] calculated for $C_{24}H_{24}N_2NaO_5$ ([M + Na]$^+$) 443.1577, found 443.1580. IR $\tilde{\nu}$ [cm^{-1}] = 2964 (w), 2875 (w), 2230 (w), 1790 (s), 1719 (s), 1695 (s), 1607 (w), 1567 (w), 1498 (w), 1481 (m), 1455 (m), 1394 (s), 1336 (s), 1289 (s), 1269 (s), 1233 (s), 1198 (s), 1174 (s), 1119 (s), 1069 (m), 1041 (s), 1016 (s), 996 (s), 890 (m), 844 (m), 821 (m), 782 (m), 749 (s), 697 (s), 636 (m), 567 (m), 545 (m), 532 (m), 505 (m), 455 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.30 [$KMnO_4$]. $[\alpha]_D^{20}$ = +38.7 (ρ = 0.99, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-(4-(trifluoromethyl)phenyl)ethyl)oxazolidine-3-carboxylate (**9**).* Synthesized following **GP-A** using 4-(trifluoromethyl)benzoic acid (142 mg, 0.75 mmol, 1.5 equiv.) and irradiating for 48 h. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **9** as a yellow oil in 61% yield (141 mg, 0.30 mmol). The spectroscopic data are consistent with those previously reported.[11] ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.1 Hz, 2H), 7.69 (d, *J* = 8.2 Hz, 2H), 7.29 (dtt, *J* = 8.3, 5.5, 2.7 Hz, 4H), 7.24−7.19 (m, 2H), 5.63 (s, 1H), 5.18 (dd, *J* = 6.9, 5.1 Hz, 1H), 5.10 (d, *J* = 12.0 Hz, 1H), 5.03 (d, *J* = 12.0 Hz, 1H), 3.54 (dd, *J* = 16.2, 6.9 Hz, 1H), 3.39 (dd, *J* = 16.2, 5.2 Hz, 1H), 1.02 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) 194.1, 171.9, 155.6, 139.1, 135.1, 134.9 (q, $^2J_{C-F}$ = 32.8 Hz), 128.8, 128.8, 128.7, 128.6, 126.0 (q, $^3J_{C-F}$ = 3.7 Hz), 123.6 (q, $^1J_{C-F}$ = 272.6 Hz), 96.5, 68.6, 53.9, 42.2, 37.6, 24.9. ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ −63.2.

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(4-formylphenyl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**10**).* Synthesized following **GP-A** using 4-formylbenzoic acid (113 mg, 0.75 mmol 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **10** as a yellow oil in 10% yield (21.2 mg, 0.05 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 10.10 (s, 1H), 8.01 (t, *J* = 8.1 Hz, 2H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.30 (dd, *J* = 5.1, 2.1 Hz, 3H), 7.25−7.20 (m, 2H), 5.63 (s, 1H), 5.21 (dd, *J* = 7.0, 5.0 Hz, 1H), 5.11 (d, *J* = 12.0 Hz, 1H), 5.03 (d, *J* = 12.1 Hz, 1H), 3.57 (dd, *J* = 16.3, 7.0 Hz, 1H), 3.41 (dd, *J* = 16.3, 5.0 Hz, 1H), 1.02 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 194.4, 191.5, 171.9, 155.6, 140.5, 139.4, 135.1, 130.0, 128.8, 128.8, 128.6, 96.5, 68.6, 53.8, 42.4, 37.6, 27.1, 24.9. HRMS (ESI) [*m*/*z*] calculated for $C_{24}H_{25}NNaO_6$ ([M + Na]$^+$) 446.1574, found 446.1573. R_f (cyclohexane/EtOAc, 4:1) = 0.16 [*p*-Anisaldehyde].

*(2S,4S)-Benzyl 4-(2-(benzo[d][1,3]dioxol-5-yl)-2-oxoethyl)-2-(tert-butyl)-5-oxooxazolidine-3-carboxylate (**11**).* Synthesized following **GP-A** using piperonylic acid (124.5 mg, 0.75 mmol, 1.5

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equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **11** as a white solid in 95% yield (208 mg, 0.47 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.48 (dd, J = 8.2, 1.8 Hz, 1H), 7.37 (d, J = 1.8 Hz, 1H), 7.32−7.28 (m, 3H), 7.23 (dd, J = 6.6, 2.9 Hz, 2H), 6.81 (d, J = 8.1 Hz, 1H), 6.04 (q, J = 1.4 Hz, 2H), 5.61 (s, 1H), 5.21 (dd, J = 6.9, 5.0 Hz, 1H), 5.11 (d, J = 12.1 Hz, 1H), 5.02 (d, J = 12.1 Hz, 1H), 3.46 (dd, J = 16.1, 7.0 Hz, 1H), 3.29 (dd, J = 16.1, 5.1 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 192.8, 172.2, 155.7, 152.2, 148.5, 135.3, 131.3, 128.7, 128.6, 128.5, 124.6, 108.1, 108.0, 102.1, 96.3, 68.3, 53.9, 41.7, 37.5, 24.9. HRMS (ESI) [m/z] calculated for $C_{24}H_{25}NNaO_7$ ([M + Na]$^+$) 462.1520, found 462.1523. IR $\tilde{\nu}$ [cm^{-1}] = 2963 (w), 1791 (s), 1718 (m), 1676 (m), 1604 (m), 1485 (s), 1443 (s), 1393 (s), 1345 (m), 1235 (w), 1176 (m), 1110 (s), 1034 (s), 930 (m), 808 (w). 733 (s), 697 (s). R_f (cyclohexane/EtOAc, 4:1) = 0.32 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +41.5 (ρ = 0.95, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(2-chlorophenyl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**12**).* Synthesized following **GP-A** using 2-chlorobenzoic acid (117.4 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 10:1) to provide **12** as a yellow oil in 95% yield (203 mg, 0.47 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.47 (d, J = 7.7 Hz, 1H), 7.41−7.39 (m, 2H), 7.33 (s, 5H), 7.32−7.28 (m, 1H), 5.61 (s, 1H), 5.22 (t, J = 6.1 Hz, 1H), 5.20−5.12 (m, 2H), 3.51−3.48 (m, 2H), 0.97 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 197.4, 172.1, 155.6, 138.5, 135.3, 132.4, 131.3, 130.7, 130.0, 128.8, 128.7, 128.6, 127.2, 96.4, 68.5, 53.7, 45.8, 37.6, 24.9. HRMS (ESI) [m/z] calculated for $C_{23}H_{24}ClNNaO_5$ ([M + Na]$^+$) 452.1215, found 452.1235. IR $\tilde{\nu}$ [cm^{-1}] = 2968 (w), 1791 (s), 1716 (s), 1589 (s), 1392 (m), 1345 (m), 1284 (m), 1176 (m), 1120 (m), 1076 (m), 1040 (m), 976 (m), 757 (m), 697 (m), 697 (s), 633 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.45 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +47.2 (ρ = 1.03, CH_2Cl_2).

*Benzyl (2S,4S)-4-(2-(2-acetoxyphenyl)-2-oxoethyl)-2-(tert-butyl)-5-oxooxazolidine-3-carboxylate (**13**).* Synthesized following **GP-A** using 2-acetoxybenzoic acid (135 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 10:1) to provide **13** as a yellow oil in 92% yield (208 mg, 0.45 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.67 (dd, J = 7.8, 1.7 Hz, 1H), 7.56−7.52 (m, 1H), 7.33−7.27 (m, 5H), 7.15 (dd, J = 8.1, 1.1 Hz, 1H), 5.60 (s, 1H), 5.19 (dd, J = 7.0, 4.8 Hz, 1H), 5.15 (d, J = 12.1 Hz, 1H), 5.06 (d, J = 12.1 Hz, 1H), 3.47 (dd, J = 16.7, 7.0 Hz, 1H), 3.31 (dd, J = 16.7, 4.8 Hz, 1H), 2.31 (s, 3H), 0.98 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 194.6, 172.1, 169.4, 155.6, 149.2, 135.4, 133.6, 130.5, 129.9, 128.8, 128.7, 128.5, 126.2, 124.1, 96.3, 68.4, 53.5, 44.9, 37.6, 24.9, 21.2. HRMS (ESI) [m/z] calculated for $C_{25}H_{27}NNaO_7$ ([M + Na]$^+$) 476.1681, found 476.1680. IR $\tilde{\nu}$ [cm^{-1}] = 2965 (w), 2875 (m), 1791 (m), 1718 (m), 1603 (s), 1346 (m), 1286 (m), 1177 (w), 1120 (m), 1041 (m), 909 (s), 7534 (m), 697 (s), 503 (s). R_f (cyclohexane/EtOAc, 4:1) = 0.37 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +41.5 (ρ = 1.01, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(3-(5-(2-fluorophenyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**14**).* Synthesized following **GP-A** using 3-[5-(2-fluorophenyl)-1,2,4-oxadiazol-3-yl] benzoic acid (213 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **14** as a yellow oil in 87% yield (243.7 mg, 0.44 mmol). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (t, J = 1.7 Hz, 1H), 8.40 (dt, J = 7.8, 1.4 Hz, 1H), 8.24 (ddd, J = 7.8, 7.0, 1.8 Hz, 1H), 8.09−8.03 (m, 1H), 7.62 (t, J = 7.8 Hz, 2H), 7.26 (t, J = 1.3 Hz, 4H), 5.64 (s, 1H), 5.27 (dd, J = 6.8, 5.1 Hz, 1H), 5.16−4.99 (m, 2H), 3.61 (dd, J = 16.4, 6.8 Hz, 1H), 3.49 (dd, J = 16.4, 5.1 Hz, 1H), 1.04 (s, 9H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 194.3, 173.3 (d, $^3J_{C-F}$ = 4.4 Hz), 172.1, 168.1, 162.3 (d, $^1J_{C-F}$ = 260.8 Hz), 155.7, 137.1, 135.2, 135.0 (d, $^3J_{C-F}$ = 8.6 Hz), 132.3, 131.1, 130.8, 129.6, 128.7, 128.7, 128.5, 127.8 (d, $^3J_{C-F}$ = 5.0 Hz), 127.4, 124.9 (d, $^3J_{C-F}$ = 3.8 Hz), 117.5 (d, $^2J_{C-F}$ = 20.9 Hz), 112.8(d, $^3J_{C-F}$ = 11.3 Hz), 96.5, 68.5, 53.8, 42.0, 37.6, 24.9. ^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$) δ −108.1. HRMS (ESI) [m/z] calculated for $C_{31}H_{28}FN_3NaO_6$ ([M + Na]$^+$) 580.1868, found 580.1854 IR $\tilde{\nu}$ [cm^{-1}] = 2962 (w), 2358 (w), 1791 (s), 1718 (m), 1621 (s), 1459 (m), 1393 (m), 1344 (m), 1289 (m), 1176 (m), 1121 (m), 1041 (m), 753 (s), 695 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.25 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +36.9 (ρ = 0.95, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-(3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)ethyl)oxazolidine-3-carboxylate (**15**).* Synthesized following **GP-A** using 4-carboxylphenylboronic acid pinacol ester (186 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **15** as a white solid in 76% yield (198 mg, 0.38 mmol). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.31 (s, 1H), 8.03−7.98 (m, 2H), 7.47 (d, J = 7.7 Hz, 1H), 7.29−7.27 (m, 3H), 7.23−7.18 (m, 2H), 5.61 (s, 1H), 5.24 (dd, J = 6.7, 5.2 Hz, 1H), 5.11 (d, J = 12.1 Hz, 1H), 4.96 (d, J = 12.1 Hz, 1H), 3.55 (dd, J = 16.3, 6.8 Hz, 1H), 3.44 (dd, J = 16.3, 5.2 Hz, 1H), 1.36 (s, 12H), 1.03 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 195.1, 172.2, 155.7, 139.9, 136.0, 135.3, 134.6, 131.0, 128.7, 128.6, 128.5, 128.3, 96.4, 84.4, 68.3, 53.9, 41.9, 37.6, 25.1, 25.0. HRMS (ESI) [m/z] calculated for $C_{29}H_{36}BNNaO_7$ ([M + Na]$^+$) 544.2480, found 544.2477. IR $\tilde{\nu}$ [cm^{-1}] = 2974 (w), 2931 (w), 2358 (w), 1793 (s), 1720 (s), 1687 (m), 1482 (m), 1390 (m), 1348 (m), 1287 (m), 1140 (m), 1041 (m), 697 (s). R_f (cyclohexane/EtOAc, 4:1) = 0.5 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +37.1 (ρ = 1.14, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-(pyridin-3-yl)-ethyl)oxazolidine-3-carboxylate (**16**).* Synthesized following **GP-A** using nicotinic acid (92.25 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **16** as a yellow oil in 45% yield (110 mg, 0.28 mmol). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.11−9.08 (m, 1H), 8.80 (dd, J = 5.0, 1.7 Hz, 1H), 8.19 (dt, J = 8.0, 1.9 Hz, 1H), 7.44 (ddd, J = 8.0, 4.9, 0.8 Hz, 1H), 7.32−7.28 (m, 3H), 7.25−7.22 (m, 2H), 5.62 (s, 1H), 5.21 (dd, J = 6.9, 5.0 Hz, 1H), 5.07 (q, J = 12.0 Hz, 2H), 3.54 (dd, J = 16.4, 6.9 Hz, 1H), 3.39 (dd, J = 16.4, 5.0 Hz, 1H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 193.6, 171.9, 155.6, 153.3, 149.1, 136.2, 135.0, 132.0, 128.8, 128.8, 128.6, 124.1, 96.5, 68.6, 53.6, 42.1, 37.6, 24.9. HRMS (ESI) [m/z] calculated for $C_{22}H_{25}N_2O_5$ ([M + Na]$^+$) 397.1757, found 397.1758. IR $\tilde{\nu}$ [cm^{-1}] = 3035 (w), 1790 (s), 1719 (m), 1480 (m), 1392 (m), 1343 (m), 1285 (m), 1176 (m), 1120 (s), 1040 (m), 1020 (m), 779 (m), 698 (m). R_f (cyclohexane/EtOAc, 1:1) = 0.4 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +42.3 (ρ = 1.04, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(1,3-dimethyl-1H-pyrazolo[3,4-b]pyridin-5-yl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**17**) and Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(4-chloro-1,3-dimethyl-1H-pyrazolo[3,4-b]pyridin-5-yl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**17′**).* Synthesized following **GP-B** using 4-Chloro-1,3-dimethylpyrazolo[3,4-b]pyridine-5-carboxylic acid (169 mg, 0.75 mmol 1.5 equiv.), and irradiating for 48 h. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 2:1) to provide **17** a yellow foam in 39% (98 mg, 0.20 mmol) and **17′** as a yellow solid in 18% yield (45 mg, 0.10 mmol). Spectroscopic data for **17**: ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.05 (d, J = 2.0 Hz, 1H), 8.49 (d, J = 2.0 Hz, 1H), 7.23 (q, J = 2.9 Hz, 3H), 7.19 (dd, J = 6.8, 3.1 Hz, 2H), 5.64 (s, 1H), 5.26 (dd, J = 6.8, 5.2 Hz, 1H), 5.11−5.01 (m, 2H), 4.11 (s, 3H), 3.59 (dd, J = 16.0, 6.8 Hz, 1H), 3.43 (dd, J = 16.0, 5.2 Hz, 1H), 2.59 (s, 3H), 1.04 (s, 9H). ^{13}C{^{1}H} NMR (151 MHz, $CDCl_3$) δ 193.2, 172.0, 155.7, 152.2, 149.5, 143.2, 135.0, 130.8, 128.7, 128.6, 128.5, 125.1, 114.8, 96.5, 68.5, 54.0, 42.0, 37.6, 33.9, 24.9, 12.6. HRMS (ESI) [m/z] calculated for $C_{25}H_{28}N_4NaO_5$ ([M + Na]+) 487.1957, found 487.1952. IR $\tilde{\nu}$ [cm^{-1}] = 2961 (s), 2926 (s), 1790 (w), 1719 (w), 1678 (w), 1599 (w), 1564 (m), 1520 (m), 1478 (m), 1392 (w), 1281 (w), 1177 (w), 1121 (m), 1041 (w), 983 (w), 748 (m), 697 (w), 578 (m), 503 (m), 456 (m), 428 (m). R_f (cyclohexane/EtOAc, 1:1) = 0.33 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +40.1 (ρ = 0.92, CH_2Cl_2).

Spectroscopic data for **17′**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.67 (s, 1H), 7.40−7.29 (m, 1H), 7.27 (tdd, J = 4.6, 3.4, 2.0 Hz, 4H), 5.63 (s, 1H), 5.23 (dd, J = 6.9, 5.4 Hz, 1H), 5.14 (d, J = 1.0 Hz, 2H), 4.07 (s, 3H), 3.60 (dd, J = 16.3, 6.9 Hz, 1H), 3.53 (dd, J = 16.3, 5.5 Hz, 1H),

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2.73 (s, 3H), 1.00 (s, 9H). $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 195.0, 171.9, 155.6, 152.3, 151.0, 142.9, 138.0, 135.1, 128.7, 128.7, 128.6, 126.1, 113.2, 96.5, 68.6, 54.2, 45.9, 37.6, 34.0, 24.9, 15.1. HRMS (ESI) $[m/z]$ calculated for $C_{25}H_{27}ClN_4NaO_5$ ($[M + Na]^+$) 521.1562, found 521.1560. IR $\tilde{\nu}$ [cm^{-1}] = 2962 (s), 2874 (s), 1791 (m), 1717 (w), 1582 (s), 1547 (m), 1515 (w), 1456 (w), 1391 (m), 1332 (w), 1285 (w), 1234 (w), 1175 (w), 1117 (m), 1038 (w), 729 (w), 697 (w), 582 (m), 503 (m). R_f (cyclohexane/EtOAc, 1:1) = 0.43 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +38.1 (ρ = 0.96, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-(1H-pyrrol-2-yl)-ethyl)oxazolidine-3-carboxylate (**20**).* Synthesized following **GP-A** using 1*H*-pyrrole-2-carboxylic acid (84 mg, 0.75 mmol, 1.5 equiv.), and irradiating for 48 h. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 5:1) to provide **20** as a dark yellow oil in 20% yield (39 mg, 0.10 mmol). ^1H NMR (600 MHz, $CDCl_3$) δ 9.42 (br, 1H), 7.40−7.27 (m, 3H), 7.24 (dq, *J* = 6.5, 4.2 Hz, 2H), 7.00 (td, *J* = 2.7, 1.2 Hz, 1H), 6.87 (ddd, *J* = 3.8, 2.4, 1.3 Hz, 1H), 6.26 (dt, *J* = 3.9, 2.5 Hz, 1H), 5.61 (s, 1H), 5.13 (t, *J* = 6.3 Hz, 1H), 5.09 (d, *J* = 12.1 Hz, 1H), 5.02 (d, *J* = 12.1 Hz, 1H), 3.33 (dd, *J* = 15.3, 6.6 Hz, 1H), 3.20 (dd, *J* = 15.3, 5.9 Hz, 1H), 1.01 (s, 9H). $^{13}C\{^1H\}$ NMR (151 MHz, $CDCl_3$) δ 184.7, 172.0, 155.7, 135.3, 131.5, 128.7, 128.6, 128.5, 125.5, 116.7, 111.0, 96.5, 68.4, 54.4, 41.3, 37.5, 25.0. HRMS (ESI) $[m/z]$ calculated for $C_{21}H_{24}N_2NaO_5$ ($[M + Na]^+$) 407.1577, found 407.1587. IR $\tilde{\nu}$ [cm^{-1}] = 3290(w), 2968 (w), 2875 (w), 2254 (w), 1790 (m), 1715 (s), 1640 (m), 1547 (w), 1481 (w), 1397 (s), 1345 (m), 1334 (m), 1292 (s), 1231 (m), 1179 (m), 1109 (s), 1067 (m), 1041 (s), 1017 (m), 979 (m), 909 (m), 727 (s), 697 (s), 648 (w), 602 (w), 582 (w), 512 (w), 455 (w). R_f (cyclohexane/EtOAc, 4:1) = 0.19 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +32.9 (ρ = 1.00, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(furan-2-yl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**21**).* Synthesized following **GP-A** using furan-2-carboxylic acid (84 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 1:1) to provide **21** as a yellow oil in 58% yield (90 mg, 0.23 mmol). ^1H NMR (400 MHz, $CDCl_3$) δ 7.55 (dd, *J* = 1.7, 0.8 Hz, 1H), 7.32 (dd, *J* = 5.0, 2.0 Hz, 3H), 7.28−7.24 (m, 2H), 7.19 (dd, *J* = 3.6, 0.8 Hz, 1H), 6.53 (dd, *J* = 3.6, 1.7 Hz, 1H), 5.60 (s, 1H), 5.17−5.10 (m, 2H), 5.00 (d, *J* = 12.1 Hz, 1H), 3.43 (dd, *J* = 15.7, 6.5 Hz, 1H), 3.24 (dd, *J* = 15.7, 6.0 Hz, 1H), 1.01 (s, 9H). $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 184.0, 171.9, 155.6, 152.5, 146.6, 135.3, 128.8, 128.7, 128.5, 117.4, 112.7, 96.5, 68.4, 53.8, 41.8, 37.5, 24.9. HRMS (ESI) $[m/z]$ calculated for $C_{21}H_{23}NNaO_6$ ($[M + Na]^+$) 408.1412, found 408.1418. IR $\tilde{\nu}$ [cm^{-1}] = 2967 (w), 1790 (s), 1719 (s), 1676 (s), 1569 (s), 1467 (s), 1392 (s), 1345 (s), 1296 (s), 1178 (s), 1121 (s), 1017 (m), 978 (m), 756 (w), 697 (s), 594 (s), 507 (s). R_f (cyclohexane/EtOAc, 4:1) = 0.3 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +41.4 (ρ = 0.95, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-5-oxo-4-(2-oxo-2-(thiophen-2-yl)-ethyl)oxazolidine-3-carboxylate (**22**).* Synthesized following **GP-A** using thiophene-2-carboxylic acid (96 mg, 0.75 mmol 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **22** as a yellow oil in 71% yield (134 mg, 0.35 mmol). ^1H NMR (600 MHz, $CDCl_3$) δ 7.71−7.64 (m, 2H), 7.33−7.27 (m, 3H), 7.24 (dd, *J* = 6.7, 2.9 Hz, 2H), 7.12 (dd, *J* = 4.9, 3.8 Hz, 1H), 5.61 (s, 1H), 5.18−5.09 (m, 2H), 5.00 (d, *J* = 12.1 Hz, 1H), 3.47 (dd, *J* = 15.7, 6.6 Hz, 1H), 3.30 (dd, *J* = 15.6, 5.6 Hz, 1H), 1.01 (s, 9H). $^{13}C\{^1H\}$ NMR (151 MHz, $CDCl_3$) δ 187.6, 171.9, 155.7, 143.7, 135.3, 134.5, 132.3, 128.8, 128.7, 128.5, 128.4, 96.5, 68.4, 54.1, 42.6, 37.6, 24.9. HRMS (ESI) $[m/z]$ calculated for $C_{21}H_{23}NNaO_5S$ ($[M + Na]^+$) 424.1190, found 424.1189. IR $\tilde{\nu}$ [cm^{-1}] = 2962 (s), 2874 (s), 1791 (m), 1717 (w), 1582 (s), 1547 (m), 1515 (w), 1456 (w), 1391 (m), 1332 (w), 1285 (w), 1234 (w), 1175 (w), 1117 (m), 1038 (w), 729 (w), 697 (w), 582 (m), 503 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.20 [p-Anisaldehyde]. $[\alpha]_D^{20}$ = +26.6 (ρ = 0.93, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(cyclohex-1-en-1-yl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**23**).* Synthesized following **GP-A** using 1-cyclohexene-1-carboxylic acid (85.8 μL, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 20:1−7:1) to provide **23** as a yellow oil in 35% yield (70 mg, 0.18 mmol). ^1H NMR 600 MHz, $CDCl_3$) δ 7.37−7.33 (m, 3H), 7.32 (d, *J* = 2.0 Hz, 3H), 6.84−6.81 (m, 1H), 5.58 (s, 1H), 5.16−5.09 (m, 3H), 3.23 (dd, *J* = 16.1, 7.3 Hz, 1H), 3.04 (dd, *J* = 16.1, 4.7 Hz, 1H), 2.25−2.20 (m, 4H), 1.65−1.56 (m, 6H), 0.98 (s, 9H). $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 128.6, 128.3, 96.1, 68.2, 53.7, 40.3, 37.4, 24.8, 21.5. HRMS (FI) $[m/z]$ calculated for $C_{23}H_{29}NNaO_5$ ($[M + Na]^+$) 422.1941, found 422.1938. IR $\tilde{\nu}$ [cm^{-1}] = 2958 (w), 2935 (w), 2872 (w), 1972 (s), 1719 (s), 1668 (s), 1497 (m), 1452 (m), 1391 (m). 1345 (m). 1289 (m). 1173 (m), 1235 (m), 1121 (m). 1040 (s), 985 (m), 736 (w), 697 (s). R_f (cyclohexane/EtOAc, 4:1) = 0.50 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +37.7 (ρ = 1.03, CH_2Cl_2).

*Benzyl (2S,4S)-2-(tert-butyl)-4-(2-(3,4-dihydro-2H-pyran-5-yl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**24**).* Synthesized following **GP-A** using 3,4-dihydro-2*H*-pyran-5-carboxylic acid (96 mg, 0.75 mmol, 1.5 equiv.). The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **24** as a yellow oil in 48% yield (39 mg, 0.24 mmol). ^1H NMR (600 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.37−7.31 (m, 5H), 5.58 (s, 1H), 5.16 (dd, *J* = 7.3, 4.8 Hz, 1H), 5.14 (dd, *J* = 12.2, 9.7 Hz, 2H), 4.05 (t, *J* = 5.3 Hz, 2H), 3.08 (dd, *J* = 15.7, 7.4 Hz, 1H), 2.94 (dd, *J* = 15.7, 4.8 Hz, 1H), 2.34−2.18 (m, 2H), 1.87−1.79 (m, 2H), 0.98 (s, 9H). $^{13}C\{^1H\}$ NMR (151 MHz, $CDCl_3$) δ 192.8, 172.3, 157.1, 155.8, 135.5, 128.8, 128.6, 128.4, 116.9, 96.2, 68.3, 67.3, 53.9, 40.0, 37.5, 24.9, 21.1, 18.5. HRMS (FI) $[m/z]$ calculated for $C_{22}H_{27}NNaO_6$ ($[M + Na]^+$) 424.1731, found 424.1739. IR $\tilde{\nu}$ [cm^{-1}] = 3065 (w), 3034 (w), 2961 (w), 2879 (w), 1791 (s), 1717 (s), 1656 (m), 1617 (s), 1481 (w), 1465 (w), 1450 (w), 1393 (m), 1345 (m), 1329 (s), 1289 (s), 1267 (m), 1230 (s), 1171 (s), 1122 (m), 1086 (m), 1041 (s), 1005 (s), 985 (s), 963 (m), 930 (m), 908 (m), 852 (m), 779 (m), 736 (m), 697 (s), 676 (m), 637 (w), 581 (w), 557 (w), 531 (w), 508 (m), 449 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.26 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +39.2 (ρ = 1.04, CH_2Cl_2).

*Benzyl (2S,4S)-4-(2-(1-(tert-butoxycarbonyl)-1,2,5,6-tetrahydropyridin-3-yl)-2-oxoethyl)-2-(tert-butyl)-5-oxooxazolidine-3-carboxylate (**26**).* Synthesized following **GP-A** using 1-(*tert*-butoxycarbonyl)-1,2,5,6-tetrahydropyridine-3-carboxylic acid (171 mg, 0.75 mmol, 1.5 equiv. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 4:1) to provide **26** as an off-white solid in 68% yield (170 mg, 0.34 mmol). ^1H NMR (600 MHz, $CDCl_3$) δ 7.35−7.29 (m, 5H), 6.89 (s, 1H), 5.57 (s, 1H), 5.18−5.08 (m, 3H), 5.09−5.06 (m, 1H), 4.09 (s, 1H), 3.45 (s, 2H), 3.23 (dd, *J* = 16.0, 7.2 Hz, 1H), 3.07−3.00 (m, 1H), 2.35−2.27 (m, 2H), 1.46 (s, 9H), 0.97 (s, 9H). $^{13}C\{^1H\}$ NMR (151 MHz, $CDCl_3$) δ 193.6, 172.1, 155.6, 154.9, 138.8, 137.0, 135.3, 128.8, 128.7, 128.5, 96.3, 80.2, 77.4, 77.2, 76.9, 68.4, 53.7, 42.3, 40.3, 38.6, 37.5, 28.5, 25.9, 24.8. HRMS (FI) $[m/z]$ calculated for $C_{27}H_{36}N_2NaO_7$ ($[M + Na]^+$) 523.2415, found 523.2410. IR $\tilde{\nu}$ [cm^{-1}] = 2972 (w), 2935 (w), 2874 (w), 1792 (m), 1720 (m), 1693 (s), 1673 (s), 1621 (w), 1479 (m), 1455 (m), 1391 (m), 1365 (m), 1342 (m), 1285 (s), 1234 (s), 1159 (s), 1111 (s), 1068 (m), 1040 (s), 985 (m), 890 (w), 865 (m), 826 (w), 766 (m), 743 (m), 697 (m), 637 (w), 593 (w), 582 (w), 508 (m), 455 (m). R_f (cyclohexane/EtOAc, 4:1) = 0.20 [$KMnO_4$]. $[\alpha]_D^{20}$ = +37.1 (ρ = 1.00, CH_2Cl_2).

*Benzyl 2-(tert-butyl)-4-(2-(4,5-dihydrofuran-3-yl)-2-oxoethyl)-5-oxooxazolidine-3-carboxylate (**27**).* Synthesized following **GP-A** using 4,5-dihydro-furan-3-carboxylic acid (86 mg, 0.75 mmol 1.5 equiv.), and irradiating for 48 h. The crude product was purified by flash column chromatography (cyclohexane/EtOAc, 2:1) to provide **27** as a yellow oil in 31% yield (60 mg, 0.15 mmol). ^1H NMR (400 MHz, $CDCl_3$) δ 7.40−7.31 (m, 5H), 7.26−7.25 (m, 1H), 5.59 (s, 1H), 5.15 (s, 2H), 5.08 (dd, *J* = 7.1, 5.3 Hz, 1H), 4.56−4.46 (m, 2H), 3.08 (dd, *J* = 15.2, 7.1 Hz, 1H), 2.95 (dd, *J* = 15.2, 5.3 Hz, 1H), 2.87−2.70 (m, 2H), 0.98 (s, 9H). $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 189.6, 172.1, 158.5, 155.8, 135.5, 128.8, 128.7, 128.5, 120.4, 96.4, 73.8, 68.4, 54.2, 42.4, 37.5, 27.4, 24.9. HRMS (ESI) $[m/z]$ calculated for $C_{21}H_{25}NNaO_6$ ($[M + Na]^+$) 410.1585, found 410.1574. IR $\tilde{\nu}$ [cm^{-1}] = 2968 (s), 1790 (w), 1716 (w), 1648 (m), 1604 (w), 1392 (m), 1334 (m), 1291 (m), 1178 (m), 1129 (w), 1042 (m), 910 (m),

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728 (w), 697 (w), 456 (m). R_f (cyclohexane/EtOAc, 1:1) = 0.33 [*p*-Anisaldehyde]. $[\alpha]_D^{20}$ = +35.2 (ρ = 1.05, CH_2Cl_2).

Derivatization Reactions. *General Procedure C (**GP-C**).* In a 4 mL vial, the corresponding oxazolidinone was dissolved in a mixture of 1,4-dioxane (1.0 mL) and conc. HCl (2.0 mL), and stirred at 80 °C in an oil bath for 2 h, monitoring by TLC. Afterwards, the reaction was concentrated *in vacuo*. To the resulting solid, cyclohexane (3 × 2.0 mL) was added and evaporated *in vacuo* to azeotrope any water residues, affording the desired α-amino acid salts.

*(S)-2-Amino-4-(2-hydroxyphenyl)-4-oxobutanoic acid hydrochloride salt (**28**).* Synthesized following **GP-C** using **12** (62.4 mg, 0.14 mmol) to afford the desired α-amino acid salt **28** as an off-yellow solid in 97% yield (35.5 mg, 0.136 mmol). ^{1}H NMR (400 MHz, D_2O) δ 7.98 (dd, J = 8.1, 1.6 Hz, 1H), 7.70 (ddd, J = 8.4, 7.3, 1.6 Hz, 1H), 7.18−7.07 (m, 2H), 4.53 (t, J = 5.3 Hz, 1H), 3.98 (d, J = 5.3 Hz, 2H). ^{13}C{^{1}H} NMR (101 MHz, D_2O) δ 204.5, 173.9, 162.1, 139.4, 132.5, 122.0, 120.8, 119.6, 50.9, 40.2. HRMS (ESI) [m/z] calculated for $C_{10}H_{11}ClNO_4$ ([M]$^-$) 244.0383, found 244.0382. $[\alpha]_D^{20}$ = +26.7 (ρ = 0.30, MeOH).

*(S)-2-Amino-4-(2-chlorophenyl)-4-oxobutanoic acid hydrochloride salt (**29**).* Synthesized following **GP-C** using **13** (51.3 mg, 0.11 mmol) to afford the desired α-amino acid salt **29** as an off-brown solid in quantitative yield (27.0 mg, 0.11 mmol). ^{1}H NMR (400 MHz, D_2O) δ 7.80 (dt, J = 7.7, 1.1 Hz, 1H), 7.69−7.61 (m, 2H), 7.55 (dt, J = 7.7, 4.3 Hz, 1H), 4.50 (t, J = 5.3 Hz, 1H), 3.90 (d, J = 5.3 Hz, 2H). The characterization data matches the reported literature.[22]

*(S)-2-Amino-4-oxo-4-(pyridin-3-yl)butanoic acid hydrochloride salt (**30**).* Synthesized following **GP-C** using **7** (78.0 mg, 0.19 mmol) to afford the desired α-amino acid salt **30** as an off-brown solid in 95% yield (45.0 mg, 0.18 mmol). ^{1}H NMR (400 MHz, D_2O) δ 8.15−8.09 (m, 2H), 7.37−7.29 (m, 2H), 4.45 (dd, J = 5.8, 4.7 Hz, 1H), 3.93−3.83 (m, 2H). The characterization data matches the reported literature.[4b]

Procedure for the Synthesis of Methyl 2-((*tert*-Butoxycarbonyl)amino)-4-oxo-4-phenylbutanoate for e.r. Measurement. In a 4 mL vial, **1** was dissolved in a mixture of 1,4-dioxane (1.0 mL) and conc. HCl (2.0 mL) and stirred at 80 °C in an oil bath for 2 h, monitoring by TLC. Afterward, the reaction was concentrated in vacuo. To resulting solid, cyclohexane (3 × 2.0 mL) was added and evaporated in vacuo to azeotrope any water residues, affording the desired salt as an off-white solid. This was dissolved in 2,2-DMP (0.1 mL) and conc. HCl (0.3 mL) was added. The resulting suspension was stirred at room temperature for 18 h. The reaction was then concentrated in vacuo. The resulting oil was dissolved in MeOH (2.0 mL) and $NaHCO_3$ (94.9 mg) and Boc_2O (97.5 mg) were added. The reaction was stirred at 50 °C for 18 h. After cooling to room temperature, the reaction was quenched with sat. aq. NH_4Cl (2.0 mL) and the organic phase was extracted with EtOAc (3 × 2.0 mL). The combined organic layers were dried over Na_2SO_4 and concentrated in vacuo. The crude product was purified by flash column chromatography (cyclohexane/EtOAc 4:1) to give the final product in 62% yield and 92:8 e.r. The spectroscopic data are consistent with those previously reported.[23] ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (dd, J = 8.4, 1.3 Hz, 2H), 7.59 (t, J = 7.4 Hz, 1H), 7.47 (dd, J = 8.3, 7.4 Hz, 2H), 5.61 (d, J = 8.8 Hz, 1H), 4.75−4.64 (m, 1H), 3.74 (s, 3H), 3.72 (dd, J = 18.0, 4.3 Hz, 1H), 3.53 (dd, J = 18.0, 4.2 Hz, 1H), 1.44 (s, 9H). The enantiomeric excess was determined by HPLC (CHIRAL PAK IA, heptane/ethanol 98:2 (v/v), λ = 220 nm, flow rate: 0.8 mL/min); t_{major} = 41.866 min, t_{minor} = 45.837 min.

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.joc.0c02951.

Emission spectra of LEDs; optimization and mechanistic studies; ^{1}H, ^{13}C{^{1}H}, and ^{19}F{^{1}H} NMR spectra; and HPLC chromatogram (PDF)

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Notes

The authors declare no competing financial interest.

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