Title	Regenerative chemiluminescent systems
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Project description: Currently, optical imaging techniques require an energy source to generate excited states capable of emitting light (fluorescence or phosphorescence). For example, fluorescence microscopy uses a light source (typically a laser); electroluminescence uses electricity and is the basis for the functioning of displays; chemiluminescence or bioluminescence (BL) uses chemical reactions, while electrochemiluminescence (ECL) can be considered a hybrid between chemiluminescence and electroluminescence as it combines electrochemical and chemical reactions (ECL). If we examine the modus operandi of BL and ECL we can clearly see some analogies as well as significant differences if attention is devoted to the consumption of the substrate and the fate of the luminophore as shown in figure 1.

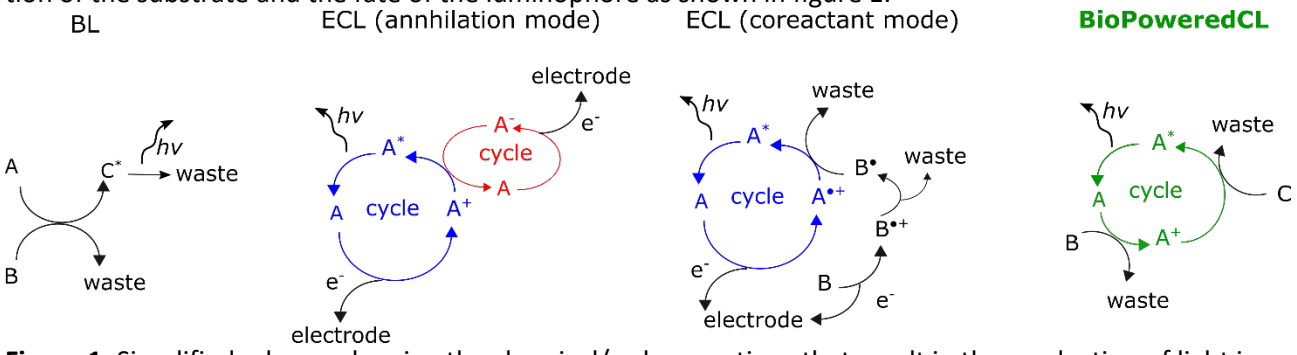

Figure 1. Simplified scheme showing the chemical/redox reactions that result in the production of light in bioluminescence (BL), electrochemiluminescence (ECL) and BioPoweredCL.

- In BL the reagents (A and B) are consumed resulting in the formation of light and waste as products. The luminophore (C) cannot be excited again through a chemical reaction (no cycles) but it has to be resynthesized. To keep light production a continuous flow of reagents is required.
- In ECL (annihilation mode) the oxidized/reduced luminophore (A^+ and A^-) are formed sequentially on the electrode surface. Annihilation of the two species results in emission of light and regeneration of the luminophore (A) (two cycles are present). It requires an electrochemical cell. To keep light production an alternate voltage is necessary.
- In ECL (coreactant mode) both the oxidized(reduced) luminophore ($A^{\bullet+}$) and coreactant ($B^{\bullet}$) are produced simultaneously on the electrode surface at a positive(negative) potential. Charge annihilation results in light emission and waste production. The luminophore is regenerated while the reactant is not (only one cycle). It requires an electrochemical cell and a continuous flow of fresh reactant.
- **In BioPoweredCL the luminophore is oxidized/reduced by chemical reactions and regenerated after each cycle. Chemical fuels are consumed which can be biological redox components. This could lead to the emission of light in living biological systems without the need for an external energy supply.**
  the PhD student will learn to synthesize and characterize organic and organometallic compounds using standard techniques (NMR, MS, etc); UV-Vis and fluorescence spectroscopy (steady state and time resolved); electrochemistry, spectroelettrochemistry and electrochemiluminescence. Then he / she will focus on regenerative chemiluminescence using a custom setup available in the laboratory.