Molecular mechanisms of cold stress tolerance in flax (*Linum usitatissimum* L.)

General context and mission of the internship: In flax, there are currently varieties qualified as winter and spring. The winter flax is sown between September 15 and the end of October, and the harvest takes place from July to mid-August. For spring flax, sowing is done between the end of February and the end of March and the harvest is usually a month later than that of winter flax. This shift in crop management allows winter flax to avoid periods of drought at the time of flowering and to stabilize yields. In 2018, winter oilseed flax covered 70 to 80% of cultivated areas. However, few winter varieties are currently available. Extensive genetic selection work has not resulted in a large number of cold tolerant varieties. The lack of information on the differences in cold tolerance behavior between winter and spring varieties prevented for many years the identification of biomarkers that could facilitate this breeding work.

Recent work carried out in the laboratory has identified potential biomarkers of cold tolerance. This work has thus characterized two new C-glycoside flavones in flax leaf: swertisin and swertiajaponin. These two flavonoids are among the majority compounds found in the leaves of 3 varieties of winter flax while they are absent in the leaves of 3 varieties of spring. This result suggests that these 2 compounds are involved in cold stress tolerance in flax (Pontarin et al., 2020; Tchoumtchoua et al., 2019). The objective of this internship is to further develop the link between the presence of flavone *C*-glucoside and tolerance to cold stress. Flax behavior will be monitored during the acclimatization period. It is indeed during cold acclimatization that the plant acquires its ability to tolerate negative temperatures. The analyzes will be carried out on varieties with contrasting tolerance profiles. The various parameters studied include:

- The freezing tolerance
- Physiological parameters (transpiration, dry matter mass)
- Profiling of primary metabolites by GC-MS and specialized by LC-MS
- Transcriptomics by RNA seq
- Deviation of the osmotic potential
- Starch content
- Oxidative state of the plant

Pontarin, N., Molinié, R., Mathiron, D., Tchoumtchoua, J., Bassard, S., Gagneul, D., Thiombiano, B., Demailly, H., Fontaine, J.-X., Guillot, X., Sarazin, V., Quéro, A., Mesnard, F. (2020). Age-dependent metabolic profiles unravel the metabolic relationships within and between flax leaves (*Linum usitatissimum*). Metabolites *10*, 2018.

Tchoumtchoua, J., Mathiron, D., Pontarin, N., Gagneul, D., van Bohemen, A.-I., Otogo N'nang, E., Mesnard, F., Petit, E., Fontaine, J.-X., Molinié, R., Quéro, A. (2019). Phenolic profiling of flax highlights contrasting patterns in winter and spring varieties. Molecules *24*, 4303.

Desired skills: the candidate must have solid skills in plant physiology and biochemistry. An interest in metabolomic would be appreciated.

Date and place of the internship: the internship will take place between January and July 2022 in UMRT BioEcoAgro INRAE 1158, BIOlogie des Plantes et Innovation (BIOPI), and in Centre de Ressources Régionales en Biologie Moléculaire of University Picardie Jules Verne (Amiens).

Application: CV + cover letter (anthony.quero@u-picardie.fr, gaelle.mongelard@u-picardie.fr).