Nowadays, nearly 90% of the promising candidates for Active Pharmaceutical Ingredient (API), as well as over 40% of APIs sold in solid form, are characterized by low aqueous solubility. The scale of this problem is alarming, once realizing that the vast majority of pharmaceuticals currently taken by patients worldwide are less soluble than a piece of a marble statue (the solubility of 13 vs. 0.63 mg/L for marble and atorvastatin, respectively). The low solubility of APIs results in their low bioavailability. Consequently, patients need to take a much higher dose of medications in comparison to the amount that effectively works on them. At the same time, a non-absorbed fraction of APIs causes a multitude of side effects coming from the irritation of a brush-border membrane of the small intestine. Furthermore, due to the solubility-limited bioavailability of taken medications in both rivers and tap water, one can find a variety of painkillers, cardiovascular drugs, antibacterials, antidepressants, and antineoplastics, among others. Consequently, it is believed that improving the aqueous solubility of such substances is currently the most crucial task of the pharmaceutical industry.

For that reason, various alternative approaches are being developed to solve the described problem. From 2000 to 2020, the conversion of crystalline drugs to their amorphous form and associated formulation of amorphous solid dispersions (ASDs) became one of the most popular approaches in the pharmaceutical industry to enhance the solubility and bioavailability of extremely poor-aqueous soluble drugs. Numerous studies have demonstrated that a crystalline material's solubility and, subsequently, bioavailability can be increased very significantly after its amorphization. It, however, comes at a cost. The main drawback of amorphous materials is limited physical stability. Therefore, on the one hand, efforts are made to find the best ways to increase the physical stability of APIs. On the other hand, however, new, alternative approaches that aim to improve API's water-solubility are constantly proposed. For instance, scientific reports discussing using eutectic mixtures to enhance drug solubility have significantly increased since 2016. Although eutectic mixtures have been known for a long time in the pharmaceutical field, their potential as systems to improve the solubility of poorly water-soluble APIs remains little explored.

Creating pharmaceutical eutectic mixtures and then turning them into an amorphous state is the project's main objective. We will look at how amorphization affects the characteristics of eutectic mixtures. The main research hypothesis assumes that such materials will exhibit high physical stability, low operation temperature and significantly improved aqueous solubility of APIs. This is because "pharmaceutical eutectic glasses" should exhibit the best features of both eutectic mixtures and amorphous materials. To verify these assumptions, in the frame of the project various multicomponent, both crystalline and amorphous, systems, will be prepared and investigated. The research work will be divided into four "P" segments (PRELIMINARY, PRINCIPAL, PIONEER, and PRAGMATIC). The first segment is called PRELIMINARY because it does not directly concern the systems that are the main subject of the project, i.e., pharmaceutical eutectic glasses. However, to obtain such materials, it is necessary to determine the eutectic concentration of investigated mixtures. as part of this step, various multicomponent compositions – physical mixtures – containing at least one API will be prepared and investigate. Based on the obtained data, the phase diagram of each composition will be constructed. The second, i.e., PRINCIPAL, segment will be focused on obtaining, investigating and characterizing amorphous systems, in particular those with eutectic concentration. In this research stage we will verify two project hypotheses (i) *amorphous mixtures possessing eutectics concentration reveal the greatest glass-forming ability among any other system concentrations*; (ii) *pharmaceutical eutectic glasses possess the highest physical stability among any other system's concentration or parental components*. The main focus of the third – PIONEER – segment is to investigate how the environment (i.e., various production and storage conditions) might impact the pharmaceutical eutectic glasses. During this research stage (i) different paths of systems amorphization (leading to the development of systems with various densities) will be employed, and (ii) the effect of elevated pressure on the amorphous eutectics will be investigated. The main hypothesis of this stage is that *fine-tuning of pharmaceutical eutectic glasses is possible when the appropriate path of amorphization is selected*. The culmination of the entire project will be the fourth – PRAGMATIC – segment. It will be focused on two main tasks. The first is designing, preparing, and testing the formulation prototypes based on the most promising pharmaceutical eutectic glasses and polymeric additives. The second task will be the comparative water solubility studies of neat crystalline and amorphous APIs, as well as their various concentrations with auxiliary components (including particularly the eutectic concentration) and prototypes of these compositions containing also other excipients that are guaranteeing appropriate viscosity for HME.