VII. SUMMARY

The filamentous fungus *Penicillium chrysogenum* is the main industrial producer of the β-lactam antibiotic penicillin. Thus, directed strain improvement to increase penicillin biosynthesis and optimize morphological features for fermentation processes is of particular interest. The aim of this work was to explore the involvement of the mating-type locus-encoded transcription factors MAT1-1-1 and MAT1-2-1 in secondary metabolism and morphology; and further the induction of the sexual life cycle in *P. chrysogenum* and the verification of sexual recombination in the derived ascospore progeny on the molecular level.

Functional analyses provided evidence that both mating-type loci control sexual mating and also a wide range of other developmental processes like penicillin biosynthesis, asexual sporulation and hyphal morphology. However, the mating-type proteins are not redundant but rather control different aspects of the same processes. MAT1-1-1 acts as a positive regulator of penicillin biosynthesis and polar hyphal growth, whereas it represses asexual sporulation. On the other hand, MAT1-2-1 is an activator of asexual spore germination and influences agglutination and surface properties of conidiospores. At the same time, MAT1-2-1 acts as a repressor of polar hyphal growth and light-dependent asexual sporulation. However, both mating-type transcription factors maintained their functions in regulating sexual development. Crossing of strains with opposite mating types led to the induction of a sexual life cycle with the formation of fruiting bodies in *P. chrysogenum*. Using RFLP analysis and whole-genome sequencing, it was demonstrated that the progeny of crosses were genetically recombinant. In addition, genomes of wild-type and production strains were adapted by sexual recombination, thereby leading to an increase of fertility.

This work revealed hitherto unknown regulatory functions of the mating-type genes in *P. chrysogenum* that are related to developmental processes of biotechnological relevance like penicillin biosynthesis and pellet morphology. Furthermore, the sexual cycle of *P. chrysogenum* was induced, resulting in recombinant ascospore progeny even in production strains. Thus, the use of sexual recombination will be a valuable tool for strain improvement to generate industrial strains with novel characteristics of biotechnological importance.