Fungal Biology

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Gene Expression Systems in Fungi: Advancements and Applications

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Preface

Strain improvement with fungal gene expression systems has a tradition of decades regarding modern fermentation industry and even millennia when we think of brewing processes for beer, wine or enzymatic processes in baking. Genetic engineering techniques developed in the last century have revolutionized fermentation industry and enabled production of enzyme mixtures and secondary metabolites with strongly increased efficiency, first by random mutagenesis, but soon also with knowledge-based targeted genome modification. Thereby, economic and optimized production of various compounds originating from diverse organisms became possible in filamentous fungi, from novel, thermostable, or cold active enzymes to potent antibiotics and antibodies to efficient anticancer drugs. At the same time, these possibilities opened up new challenges to be solved, like precise regulation of gene expression during the growth phase for optimized product yield and expression of heterologous proteins with unusual characteristics in a production organism.

This volume aims to give a broad overview on gene expression systems in biotechnological workhorses for production of enzymes and metabolites from the phyla of ascomycetes and basidiomycetes and the subphylum mucoromycotina. Additionally, we include model organisms that have provided valuable insights into the physiology of fungi, also with respect to industrial applications and, for example, the corn smut fungus *Ustilago maydis* as an alternative expression system. For the diversity in potential fungal hosts for production of a given compound, strain collections and for fungi particularly the Fungal Genetics Stock Center represent an invaluable resource for research and application, which is discussed in a dedicated chapter.

The "Tools" section summarizes current and versatile methods for strain manipulation, such as high throughput construction of genetically modified fungi and strategies for activation of silent secondary metabolite gene clusters and targets for improvement such as the mechanism of carbon catabolite repression. However, also novel strategies and tools that became available in recent years or have raised increased attention are highlighted. The use of inteins in protein synthesis is one example of such intriguing avenues for protein expression, and signal transduction pathways of fungi still remain to be exploited further for optimization of production processes.

In the last few years also, sexual development was achieved with industrial fungi, which were believed to develop only clonally for decades. *Trichoderma reesei* was the first one, for which this tool became available and more and more others are following thanks to considerable effort of the fungal scientific community. In this volume we included two chapters on the perspectives and challenges of application of sexual development for strain improvement.

Last but not least, the section on "Challenges" aims to provide insight into the perspectives and needs in industry and discusses safety issues with recombinant production organisms.

With this volume we aim to provide a profound resource for scientists in research and industry alike as well as for students starting their work on application-oriented research with fungi. We intend to inspire researchers to combine classical and novel strategies to meet the challenges with fungal biotechnology in economical and environmentally safe production of the diverse products that make our life more convenient like enzymes or to even save it with novel antibiotics and drugs.

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