Chapter 11
Methods of Preparation of Nanoparticle Formulations for the Treatment of COPD: A Short Review

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ABSTRACT
The incidence of chronic obstructive pulmonary disease (COPD) has increased many folds in the last couple of decades. This can be explained by the increased pollution levels and drastic changes in the lifestyle of the people. Taking a note of this, in this review, a conscious attempt was made to understand the physiological changes in the respiratory tract in a COPD patient. Nanoparticulate formulations play an extensive role in the current-day treatment regime of COPD patients. Hence, different methods for developing nanoparticulate formulations for the treatment of COPD are discussed in details.

INTRODUCTION
Chronic obstructive pulmonary disease (COPD) is one of the most common diseases with high mortality rate across the globe (Aryal, Diaz-Guzman, & Mannino, 2013). The patient often becomes a burden to the families (Miravitlles, Peña-Longobardo, Oliva-Moreno, & Hidalgo-Vega, 2015). This may be

attributed to the high cost associated with the treatment of COPD (Lee & Goldstein, 2015). Additionally, the requirement for an extensive care becomes a necessity for these patients (Perera, Armstrong, Sherrill, & Skrepnek, 2012). This further provides an additional burden to the families. The families, who are economically sound, can hire the services of caregivers. Due to the high cost associated with the hiring of the services of caregivers, most of the families, not only in the developing world but also in the developed countries, are unable to hire the services of the caregivers (Mansfield, et al., 2016). We have to bear in mind that the COPD patients, in their early and mid stages of the disease, are often unable to do the day-to-day activities with relative ease (Monjazebi, et al., 2016). This is due to the disability of the patients (Braido, et al., 2015). Though the name of the disease COPD suggests a chronic obstruction of the air flow to the lungs, the efficiency of the alveolar ventilation and gas exchange also play an important part in COPD (Antonaglia, Ferluga, & Lucangelo, 2016). The abnormalities present in the gaseous exchange quite often lead to sleep disorder, dyspnoea and also a relative increase in the strain experienced while breathing (McNicholas, Verbraecken, & Marin, 2013; Miki, et al., 2013). This, eventually, may further lead to hypoxia (a clinical condition where the oxygen concentration in the tissue is very low) and hypercapnia (a clinical condition where the concentration of carbon dioxide gas in blood is very high) (Kuklisova, Tkacova, Joppa, Wouters, & Sastry, 2016; Littleton, 2015; Zheng, et al., 2016). There is also a marked reduction in the respiratory reserve volume of the COPD patients (Guenette, Webb, & O’Donnell, 2012). Many scientists have predicted that there is an increase in the number of COPD patients due to the increased frequency of smoking and ageing population (Chiappa, Winn, Viñuela, Tipney, & Spector, 2013; Lahousse, et al., 2016). An increase in the air pollution is also playing a major role in the deterioration of the functioning capability of the lungs, thereby, promoting the progression of the disease (Bloemsma, Hoek, & Smit, 2016).

In the present study, we will discuss about the pathophysiological changes in the lungs of the COPD patients and the drug delivery/formulation technologies employed in the treatment of the COPD patients.

**Anatomy and Physiology of Human Respiratory Tract**

The respiratory and the cardiovascular systems form an interconnected system (Gimeno-Santos, et al., 2014). The deoxygenated blood is pumped into the lungs for oxygenation by the right ventricle of the heart. After oxygenation of the blood, the blood is drained into the left atrium. The oxygenated blood then enters into the left ventricle from where it is pumped into the body through the aorta through the aortic valve (Hall, 2015). The lungs are the parts of the respiratory system (Figure 1). The respiratory system is classified into upper and lower respiratory tracts (Charlson, et al., 2012). The upper respiratory tract consists of nose, nasal cavity and pharynx, whereas, the lower respiratory tract consists of larynx, trachea, bronchi and the lungs (Beachey, 2013). The trachea bifurcates into two bronchi. Each of these bronchi gains entry into the right and the left lungs, respectively. As the bronchi enter into the lungs, they form smaller bronchioles. The bronchioles then terminate into alveoli. The alveoli are highly vascularised tissue, which promotes the exchange of oxygen and carbon dioxide across the alveolar membrane (Reece, 2015). This exchange of gases allows the maintenance of oxygen and carbon dioxide balance in the blood. During the respiration process, the air is inhaled through the nose which subsequently gains entry into the nasal cavity, where the conditioning of the inhaled air takes place. The conditioned air then passes through the pharynx, larynx, trachea and bronchi to reach the alveoli. After the exchange of the gases have taken place in the alveoli, the air moves in the reverse direction and is exhaled from the nose. A healthy adult lung has the capacity to accommodate 1 pint (~500 ml) of air during each inhala-
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