SUMMARY

The study of blood flow in stenosed artery with different flow geometries, flow situations and conditions, seems to be important from physiological and clinical points of view. A good number of well known and intensive investigations brought forwarded by eminent biomechanists Chien, Dintenfass, Haynes, Caro, Goldsmith, Salak, Young, Fung, MacDonald, Puniany and Nimi, Biswas and many others, have clearly indicated that the rheologic and fluid dynamic studies of blood and blood flow, could play a vital role in the fundamental understanding, diagnosis, prognosis, treatment etc. of many diseases viz., cardiovascular, cerebrovascular, renal, arterial disorders, hematological etc. It is also reported that hydrodynamic and fluid dynamic factors could play a significant role in the growth, development and progression of arterial stenosis which may be localized at one or more locations at the lumen of an artery. Further, as stenosis may be symmetric and asymmetric, it could be realistic to consider an asymmetric stenosis that includes symmetric form as a particular case.

Atherosclerosis or, stenosis is a kind of cardiovascular (CVS) disease in human being it is reported that this type of CVS diseases accounts for nearly 30% of deaths worldwide. One of the major factor behind this huge number of causalities, is reported as the narrowing of an artery or, atherosclerosis. The formation, development and progression of atherosclerosis is strongly correlated with wall shear stress and blood cells interactions. The region of low shear stress has been identified as the site where the atherosclerosis beings. It seems important to explore the role of wall shear stress at the site of stenosis. Further, pressure-flow relationship alters significantly due to the presence of stenosis at one or more places of circulatory system.

Bugliarello and Sevilla, Cokelet have indicated experimentally that for blood flow through small arteries, there exists a cell-poor plasma (Newtonian fluid) layer and a core region of red cells (erythrocytes). Bugliarello and Sevilla have presented the flow of blood in small diameter tubes by a two-layered model assuming peripheral and core fluids as Newtonian fluids of different viscosities. It seems important to investigate blood flow in a two-layered model by considering blood to act as Newtonian and non-Newtonian fluids.
The present study accounts for (i) the mathematical modeling on blood flow, (ii) steady flow behaviour of blood in different flow geometries, (iii) two-layered flow of blood, (iv) an inclined uniform stenosed artery, (v) asymmetric stenosis formation at vessel wall, (vi) the marvelous body fluid blood characterizing Newtonian and non-Newtonian nature, (vii) successive growth of stenosis at artery wall, (viii) the presence and absence of body force, (ix) velocity slip condition at interface of fluids with different viscosities, (x) blood flow in annular and non-annular regions.

The aim of the present work is

a. To study the Newtonian and non-Newtonian behaviour of blood and its flow through an inclined or non-inclined catheterized or uncatheterised uniform artery.

b. To study the two-layered blood flow.

c. To study the effect of inclination for flow through a constricted uniform artery.

d. To explore the role of symmetric and asymmetric stenosis on unidirectional blood flow in annular region.

e. To study the combined influenced of several parameters such as, velocity slip at interface, inclination, two-layered modeling, stenosis size and its non-symmetric on blood flow in a uniform constricted artery.

Chapter 1 present a general introduction including general and relevant information about cardiovascular system (CVS), its primary components, their composition and role in blood flow, basic information about on arterial stenosis or atherosclerosis, its formation, development progression, effects and its treatment modalities, along with unidirectional blood flow and two-layered blood flow, several relevant theoretical model and a brief account of the present work.

Chapter 2 accommodates a brief review of literature which includes the relevant theoretical models and experimental observations on blood flow through different geometries and flow situations. The Newtonian and non-Newtonian models and, two-layered blood flow situations are also included here.
Chapter 3 accounts for two-layered steady blood flow in uniform artery with the formation of asymmetric stenosis, subject to the introduction of a velocity slip condition at interface of Newtonian fluids with different viscosities. The basic equation for fluid flow is presented and the governing equations of unidirectional blood flow are integrated, using the boundary conditions used. Analytical expressions of different flow variables in two forms are obtained and their variations with flow parameters, are presented graphically, discussed and concluded thereof.

Chapter 4 addresses two-layered blood flow through an inclined uniform artery with the growth of asymmetric stenosis and velocity slip condition at interface of Newtonian fluids with distinct viscosities. Body fluids blood is assumed to act as Newtonian fluid and, flow is steady and one-dimensional. Analytical expressions of flow variables in two different forms are obtained and their variations with several flow parameters are presented graphically.

Chapter 5 deals with annular blood flow in two-layered model of a uniform constricted artery with velocity slip condition at interface of Newtonian fluids with separate viscosities. The annular region is confined between a catheter and vessel wall or fluids-interface. Analytical expressions of flow variables are obtained in both forms and their variations with relevant parameters are presented graphically.

Chapter 6 accommodates two-layered Casson fluid model for a uniform constricted artery. Blood is assumed to behave as Casson fluid in the core region and peripheral layer plasma is represented by a Newtonian fluid. Analytical expressions of flow variables are obtained in two forms and their variations with flow parameters, are presented in figures.

Chapter 7 includes two-layered Bingham plastic model for a uniform constricted artery. Blood is considered as Bingham plastic fluid in the core region and Newtonian fluid in the peripheral layer. A velocity slip condition is employed at the interface of fluids. Analytical expressions in two forms have been obtained and their variations with flow parameters are shown graphically.

In the present study, uni-directional steady flow of blood, through a uniform constricted artery with the employment of velocity slip condition at interface of a two-layered model at five different flow situations, has been considered. The aim is to get
an insight in such complicated blood flow situations. It is clear from the present investigation that with the employment of an axial velocity at the interface, damages to a diseased artery could be lowered. It therefore appears that an accurate and appropriate measure of an apparent slip in velocity slip is to be obtained both theoretically and experimentally. The present mathematical models may be used as a tool, for measuring such velocity slip.

The proposed mathematical models can be improved further by taking (i) two kinds of velocity slip in radial and axial directions, in two-dimensional blood flow models, (ii) parameters viz, variable slips, magnetic and electric effects, body acceleration etc., (iii) inertia terms, pulsatile flow of blood, porosity etc. our intention is to propose such type of blood flow models in future.