GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1996

BIOENGINEERING

EXAM AREA

Assigned Number **(DO NOT SIGN YOUR NAME)**

-- Please sign your name on the back of this page --

1. Blood flow in arteries is normally laminar in most peripheral vessels. However, this flow may exhibit different patterns at certain anatomic locations and with disease.

   a) Describe the blood flow patterns that might be found in the region of the normal renal artery orifice.

   b) Describe the blood flow patterns at this branch point with a renal artery stenosis.

   c) How can the fluid mechanics be quantified in the disturbed flow region downstream of the stenosis?

   d) As the stenotic disease progresses, what would you expect the pressure to be like in the afferent arterioles of the kidney?

   e) Are there any systemic physiological consequences which may arise from progressive disease at the renal orifice?

2. In general, the mechanics of soft tissues involves (i) constitutive nonlinearity, (ii) viscoelasticity, (iii) large deformation, and (iv) anisotropy.

   a) For each of (i) - (iv) listed above, briefly describe a simple experiment which reveals such characteristics.

   b) For each of (i) - (iv) listed above, briefly comment on what have to be done differently in dealing with the mechanics of soft tissues in comparison to dealing with the mechanics of traditional engineering materials such as steel.

3. A mammalian cell can be viewed as a mechanical structure. From this perspective, answer the following.

   a) What are the main structural elements? Discuss what role each might play.

   b) Does the membrane of the cell contribute to structural integrity? If so, how? If not, what role does the membrane play?

   c) When a mammalian cell is subjected to a physical force, what mechanisms are possibly involved in the cell's recognition of its physical force environment?