

Assignment 2

Problems 1.16, 1.18, 1.23, 1.24, 1.26 of
“Fundamentals of statistical thermal physics” by
F.Reif

(pdf of this chapter is already uploaded on
Moodle)

Deadline: 11 PM on 16/9/2017

Project 1

Survival Probability of a Blind Rat

A blind cat and a blind rat on a square lattice



L : box length

R : grid size

N : total cells

$$N = L^2/R^2$$

Case-I:

At $t=0$, the rat and the cat are located at diagonally opposite corners.

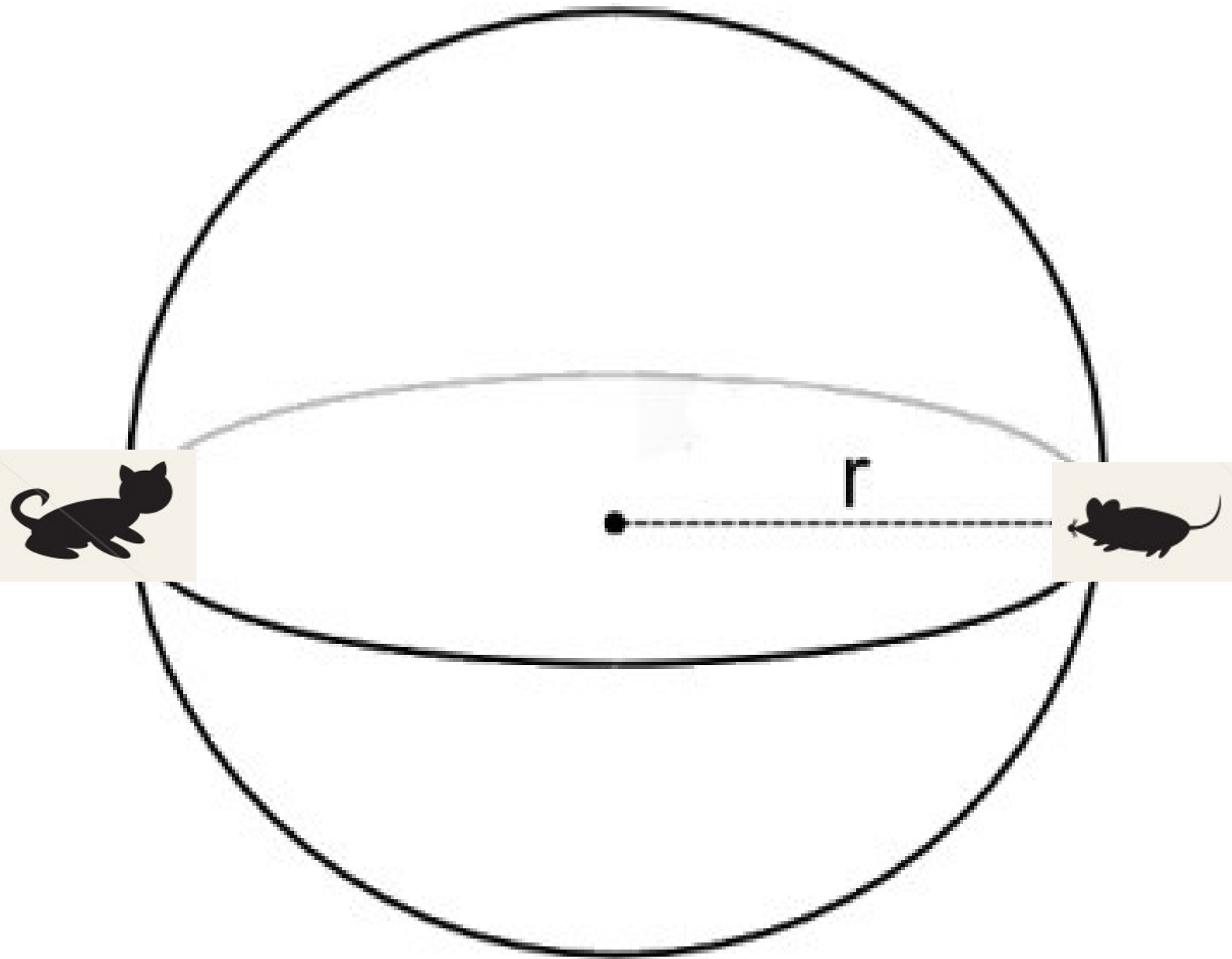
Case-II:

At $t=0$, they are at the center of the lattice.



Rat and cat make random steps (step length along x = step length along y = R) simultaneously. Each step can be either along the x -axis or along the y -axis. Use reflecting boundary conditions.

A blind cat and a blind rat on a sphere



Case-I:

At $t=0$, the rat and the cat are diametrically opposite to each other.

Case-II:

They start from the same point.

Questions

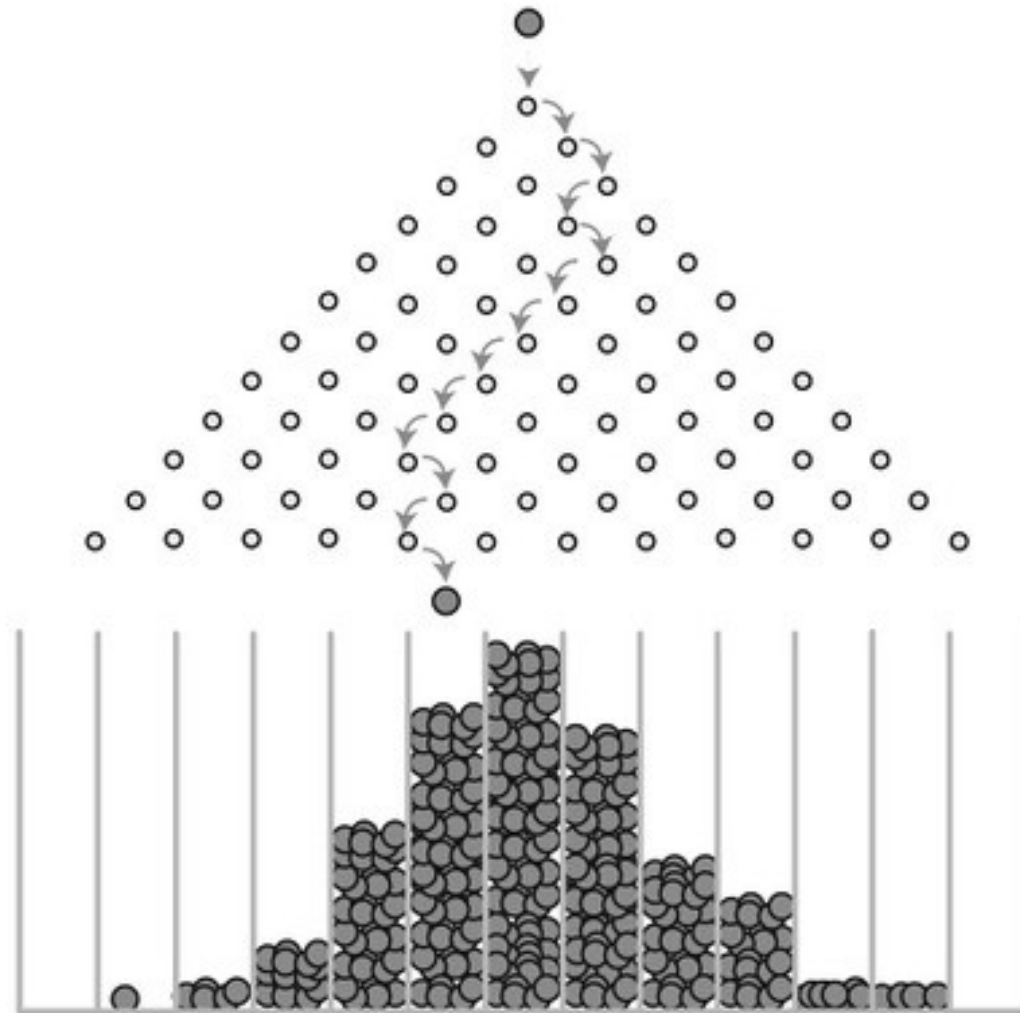
- (1) How does the survival probability of the rat vary with time?
 - (2) Does the survival probability depend on (a) L of the square (b) r of the sphere? Derive the relationship.
 - (3) Can you determine the limiting value of the survival probability when the step length is infinitesimally small and the number of steps is sufficiently large?
- (Note: questions (1)-(3) should be solved analytically.)**
- (4) Solve these problems computationally.

State your assumptions clearly. You need to upload a written report as well as a video report on Moodle by 11 PM on 20/9/2017.

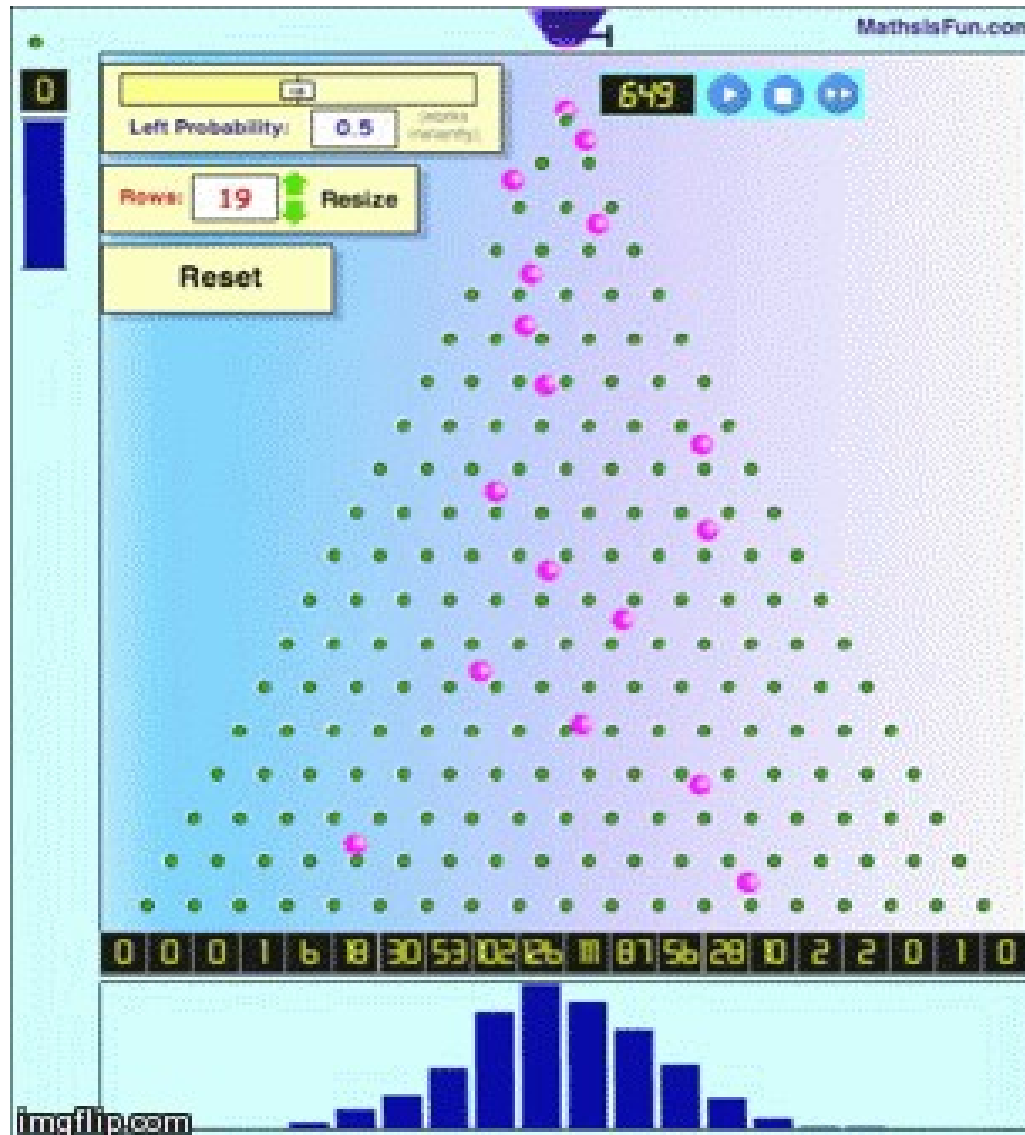
Project 2

Oxygen transport through myoglobin

Galton's board

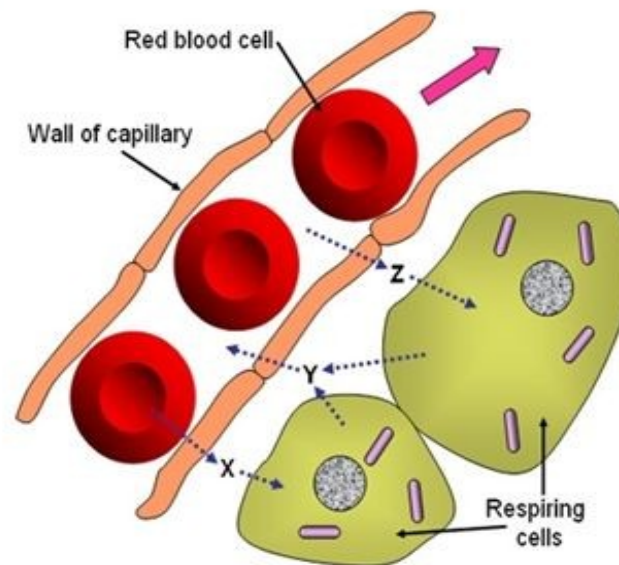
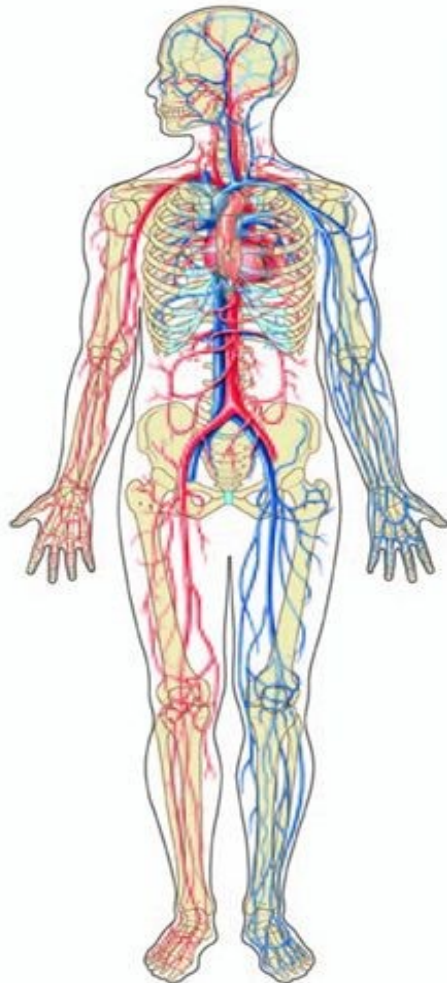


Galton's board



Oxygen transport by myoglobin

Myoglobin (Mb) and Hemoglobin (Hb) have related, but different, roles in the body

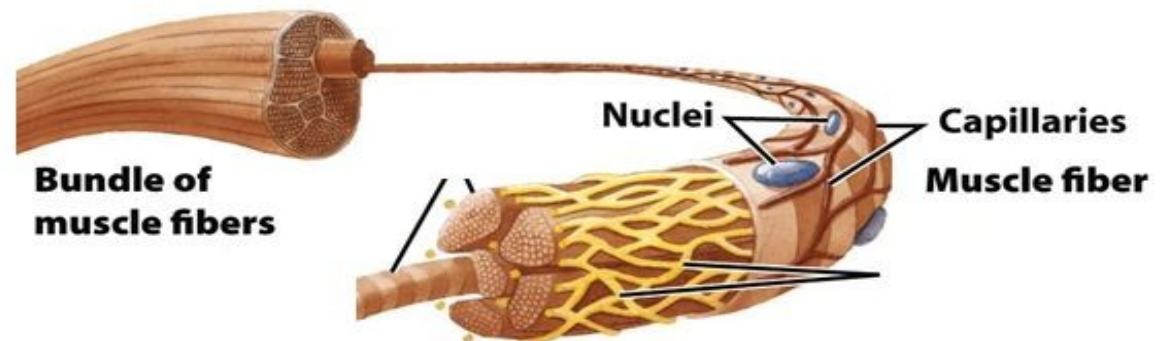


Hemoglobin:

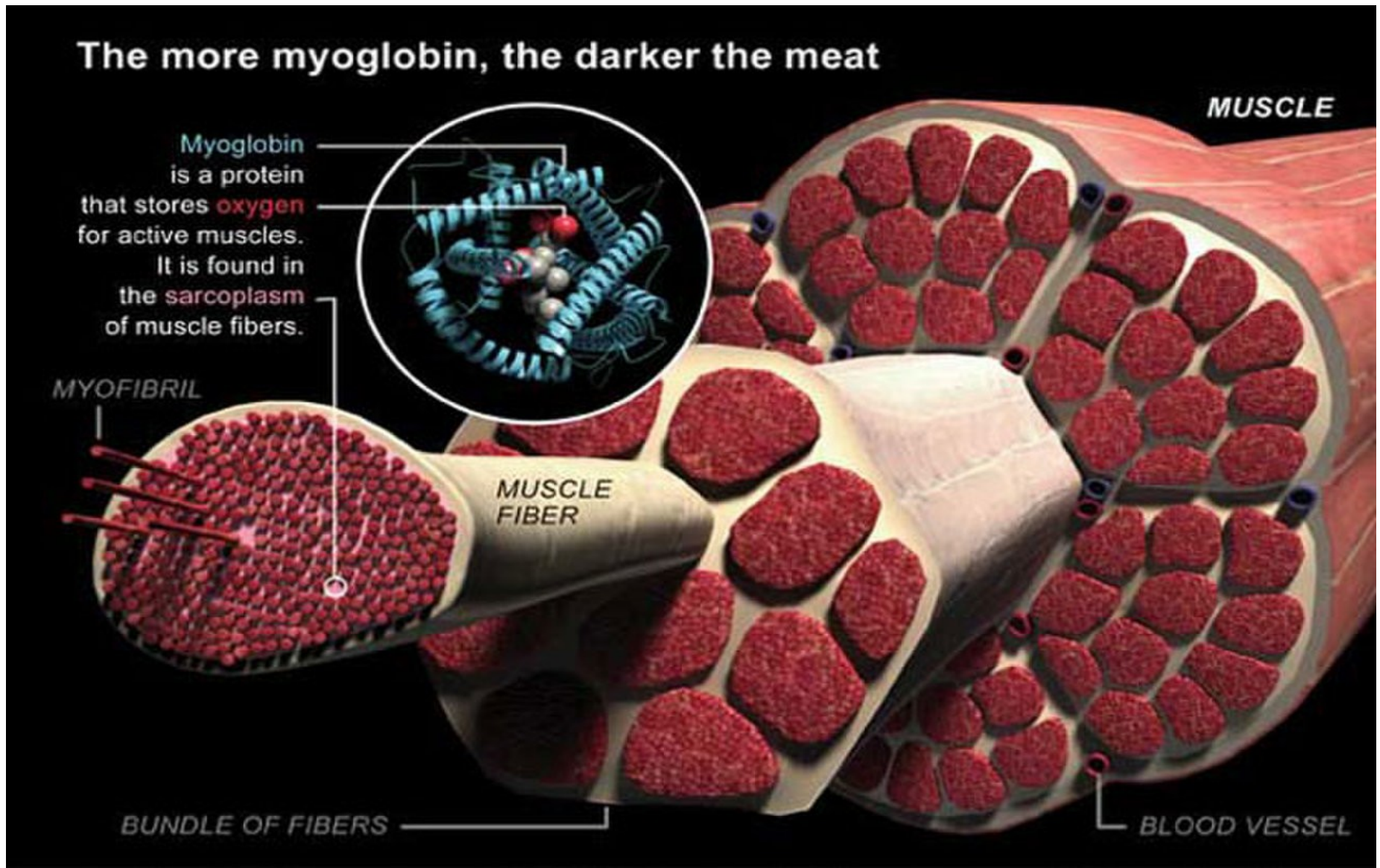
- Found in red blood cells
- Promotes diffusion of O_2 throughout the body (binds O_2 at lungs, releases at tissues)

Myoglobin:

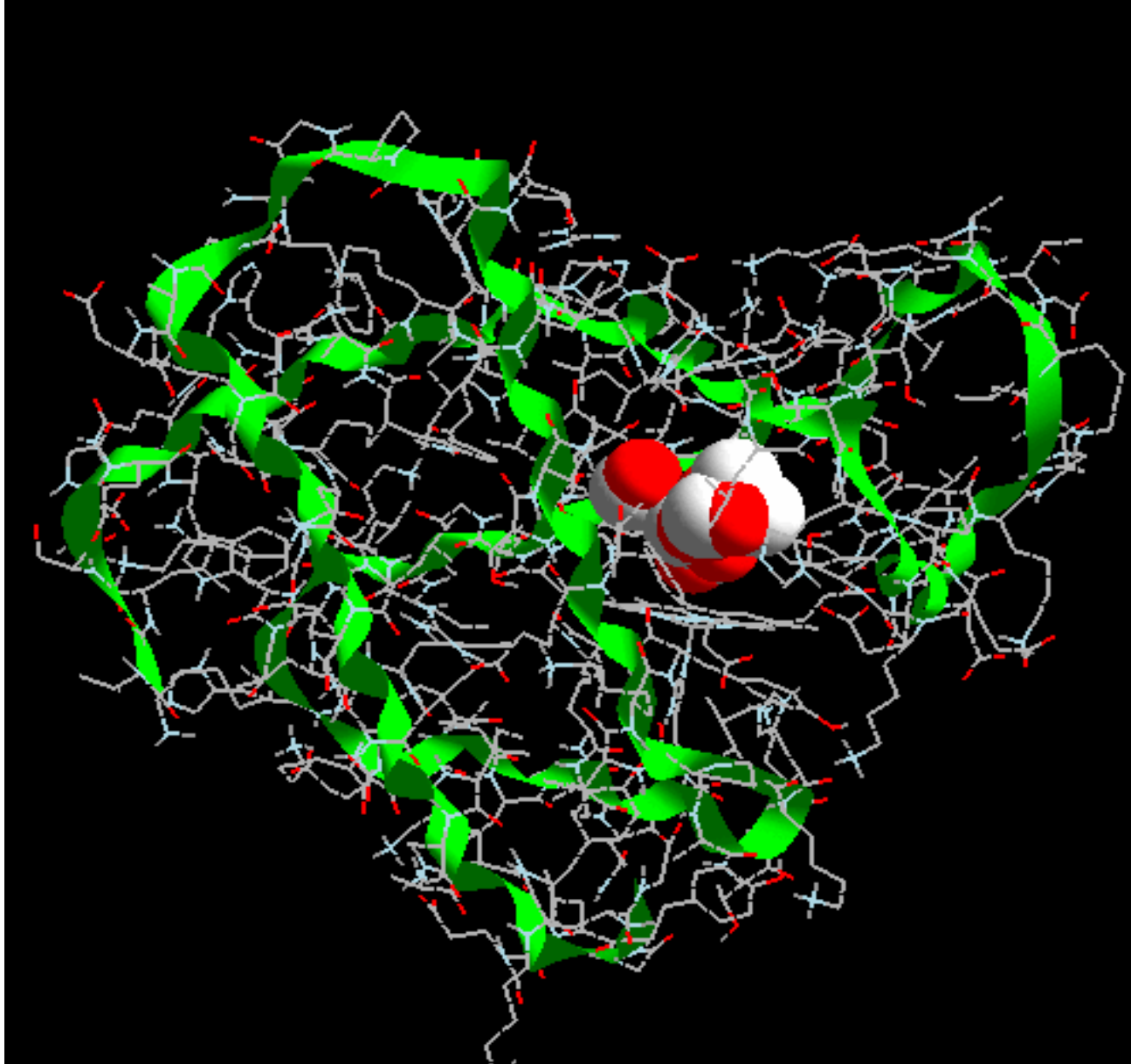
- Found in muscle cells
- Promotes diffusion of O_2 into and throughout muscle cell



Oxygen transport by myoglobin



Oxygen transport by myoglobin



Question

(1) Using the spherical galton's board model (concentric spheres consisting of arrays of nails), investigate the transport (for example, mean displacement and mean square displacement) of a spherical particle (representing an oxygen molecule) from the surface to the center (representing the binding site of the protein) of the sphere (representing a protein). Each nail on this spherical galton's board can be considered as a point. It is given that the separation between any two adjacent concentric spheres is a constant and that the distance between any two near-neighbor nails on any given concentric sphere is also a constant.

State your assumptions clearly. You need to upload a written report as well as a video report on Moodle by 11 PM on 20/9/2017.