Answers to exercises of Chapter 1 (Networks in Biology)

1. Describe the information flow within a cell, from DNA to metabolism. Name the processes.

The process of information transmission from DNA to proteins is called gene expression. This process can be divided into two main parts, transcription and translation. During transcription, an RNA (transcript) corresponding to one strand of the DNA is synthesized. During translation, amino acid chains are synthesized from the RNA by the ribosomes. These amino acids chains are then folded into a certain structure to yield proteins. A subset of the proteins, the enzymes, is responsible for converting one metabolite into another. The whole body of enzymes and metabolites is called metabolism. All these processes are regulated at various levels.

2. What are the four levels of protein structure?

Primary structure: amino acid sequence.
Secondary structure: regular 3-dimensional patterns such as loops, helices, or sheets.
Tertiary structure: arrangement of these patterns in space.
Quaternary structure: arrangement of the subunits to form an active protein complex.

3. Describe the organization of a cell.

See Section 1.2.2 and Figure 1.3.

4. In a regular cell of most organisms, how many copies of each gene are present?
Why?

Four. Most (higher) organisms are diploid; they contain two copies of each chromosome. These in turn contain two chromatides each. However, there are a lot of exceptions like reproductive cells, bacteria, other unicells, plants with higher ploidie levels, organelle-encoded genes, and so on.

5. Describe the term “systems biology” with your own words.

Needless to say, there are countless correct answers here. In the authors opinion, the answer should contain something like “system-level understanding”, which cannot be reached just by measuring everything. The processes need to be considered in their entirety, which can only be accomplished using computer-aided modeling and simulation.

6. What are -omes and -omics?

-omes: entire set of biochemical components of one kind (e.g., genome, proteome).
-omics: techniques to identify this set (e.g., genomics, proteomics).

7. Why is the measurement of a complete transcriptome not yielding a network?

It does not directly contain any connectivity information. It’s just a list of values.

8. Name the at least four microscopic and two macroscopic networks in biology.

Microscopic: transcriptional regulatory networks (or gene regulatory networks), signal transduction networks, metabolic networks, protein interaction networks, other networks containing two or more of these classes.
Macroscopic: phylogenetic networks, ecological networks (containing food webs, plant-pollinator interaction networks, etc.).

9. Why are correlation networks not intrinsic biological networks?

Correlation networks are not a direct result of experimental data, but they are determined by collecting large amounts of high-throughput data and calculating the correlations between all elements.