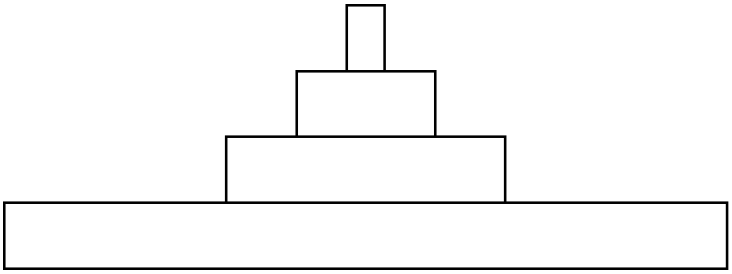
2. ATP and GTP are primary sources of energy for biochemical reactions.

   (a) **Describe** the structure of the ATP or the GTP molecule.

   (b) **Explain** how chemiosmosis produces ATP.

   (c) **Describe** TWO specific cell processes that require ATP and explain how ATP is used in each process.

   (d) An energy pyramid for a marine ecosystem is shown below. **Label** each trophic level of the pyramid and provide an example of a marine organism found at each level of this pyramid. **Explain** why the energy available at the top layer of the pyramid is a small percentage of the energy present at the bottom of the pyramid.



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3. Phylogeny is the evolutionary history of a species.

   (a) The evolution of a species is dependent on changes in the genome of the species. **Identify** TWO mechanisms of genetic change, and **explain** how each affects genetic variation.

   (b) Based on the data in the table below, **draw** a phylogenetic tree that reflects the evolutionary relationships of the organisms based on the differences in their cytochrome *c* amino-acid sequences and **explain** the relationships of the organisms. Based on the data, **identify** which organism is most closely related to the chicken and **explain** your choice.

   (c) **Describe** TWO types of evidence—other than the comparison of proteins—that can be used to determine the phylogeny of organisms. **Discuss** one strength of each type of evidence you described.

THE NUMBER OF AMINO ACID DIFFERENCES IN CYTOCHROME *c* AMONG VARIOUS ORGANISMS

	Horse	Donkey	Chicken	Penguin	Snake
Horse	0	1	11	13	21
Donkey		0	10	12	20
Chicken			0	3	18
Penguin				0	17
Snake					0

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Question 2

ATP and GTP are primary sources of energy for biochemical reactions.

(a) **Describe** the structure of the ATP or the GTP molecule. **(1 point each; 2 points maximum)**
- Adenosine + 3 phosphates or guanosine + 3 phosphates.
- Elaborating on the phosphate bonds, e.g., unstable, negatively charged. Mentioning without explaining "high-energy bonds" is insufficient.
- Adenosine or guanosine described as adenine or guanine bound to ribose.

Note: adenine + ribose + 3 phosphates earns 2 points.

(b) **Explain** how chemiosmosis produces ATP. (**1 point each; 3 points maximum)**
- Electron transport, e.g., linked to proton pumps, coenzymes, NADH.
- H+ pumped to one side of the membrane, photosynthesis—inside thylakoid, respiration—outside cristae.
- Proton gradient established, has potential energy or capacity to do work.
- ATP synthases or channel proteins generate ATP.

(c) **Describe** TWO specific cell processes that require ATP and explain how ATP is used in each process. **(4 points maximum)**

	Description of process **(1 point per process; 2 points maximum)**	**How ATP is used** **(1 point per process; 2 points maximum)**
Mechanical	Muscle, sliding filament; cilia or flagella, propulsion; chromosome movement in mitosis or meiosis	ATP → ADP + P connected to process or energy coupling, e.g., conformational change in myosin head
Transport	Active transport or transport against gradient; sodium-potassium pump; endocytosis or exocytosis	ATP → ADP + P connected to process, e.g., phosphorylating the transport protein
Chemical	Hydrolysis or synthesis; specific chemical reaction, e.g., photosynthesis or glycolysis; kinase activity	ATP → ADP + P connected to process or energy coupling, e.g., phosphorylating glucose in glycolysis or PGA in Calvin cycle

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Question 2 (continued)

(d) An energy pyramid for a marine ecosystem is shown below. **Label** each trophic level of the pyramid and provide an example of a marine organism found at each level of this pyramid. **Explain** why the energy available at the top layer of the pyramid is a small percentage of the energy present at the bottom of the pyramid. **(3 points maximum)**

	Explanation **(1 point per box; 3 points maximum)**
Label trophic levels	Producer or autotroph → 1° consumer or herbivore → 2° consumer or carnivore → 3° consumer; no point for mentioning detritivores or decomposers
Examples of <u>marine</u> organisms	Algae → zooplankton → small fish → shark Type of plankton must be specified if used above producer level; "fish" can be used <u>once</u> if unspecified; top level may include terrestrial organisms
Energy transfer	Energy transferred due to metabolic activities, heat, work, entropy Mentioning without explaining 10% energy transfer between trophic levels is insufficient

Note: Students must receive points in all four sections to earn a score of 10.