**Introduction**

This prompt is the culmination of the two prior prompts.

* One prompt was instructing GPT-3 to find the function, mechanism, and context of the organism in the sample.
* The second prompt was telling GPT-3 to find the organism and part of the organism performing the function.

Additionally, it builds off of the prompt in “Get\_Bio\_Strategy\_1” in that we define the biological elements in the strategy, rather than just listing them.

We want GPT-3 to find all elements of a biological strategy in a concise form, and we noticed for GPT-3 to be concise, we have to teach it how. Thus, we included a sample in the prompt.

**Structure of Prompt**

* Directions
  + Directions
    - Definition of biological strategy (first sentence)
    - List and define the main elements of the strategy
    - Tell GPT-3 to include all the elements extracted in the strategy
  + One-Shot Sample
    - Sample “Text” → Tungara Frog …
    - Sample “Output”
  + Input
    - Input “Text” → {}
    - Output start → “Function:”
      * GPT-3 only needs the first part of the output (in fact, it may not even need this)

**Prompt**

A biological strategy is a characteristic, mechanism, or process that an organism or ecosystem exhibits to accomplish a particular function within a particular context.

The main elements of a biological strategy are:

- The function of the organism, as in what is the organism trying to accomplish?

- The mechanism of the organism, describe how the organism does the function.

- The context of the organism performing the function. This could be a place, condition, or situation.

- The organism or ecosystem is performing the function.

- The part of the organism that is used to perform the function if it is stated in the text.

Make sure the biological strategy is composed of the function, mechanism, context, organism, and part of the organism.

Text: Building a home from foam-túngara frog foam nest architecture and three-phase construction process. frogs that build foam nests floating on water face the problems of over-dispersion of the secretions used and eggs being dangerously exposed at the foam : air interface. nest construction behaviour of tungara frogs, engystomops pustulosus, has features that may circumvent these problems. pairs build nests in periodic bursts of foam production and egg deposition, three discrete phases being discernible. the first is characterized by a bubble raft without egg deposition and an approximately linear increase in duration of mixing events with time. this phase may reduce initial over-dispersion of foam precursor materials until a critical concentration is achieved. the main building phase is marked by mixing events and start-to-start intervals being nearly constant in duration. during the final phase, mixing events do not change in duration but intervals between them increase in an exponential-like fashion. pairs joining a colonial nesting abbreviate their initial phase, presumably by exploiting a pioneer pair's bubble raft, thereby reducing energy and material expenditure, and time exposed to predators. finally, eggs are deposited only in the centre of nests with a continuously produced, approximately 1 cm deep egg-free cortex that protectively encloses hatched larvae in stranded nests.

Function: protect hatched larvae

Mechanism: building nests

Context: periodic bursts of foam production and egg deposition on water

Organism: Túngara frog

Part of: Nest

Strategy: Túngara frogs protectively enclose hatched larvae by building nests during periodic bursts of foam production and egg deposition on water

**Test in OpenAI Playground**

Text: Harbor seal vibrissa morphology suppresses vortex-induced vibrations. Harbor seals (Phoca vitulina) often live in dark and turbid waters, where their mystacial vibrissae, or whiskers, play an important role in orientation. Besides detecting and discriminating objects by direct touch, harbor seals use their whiskers to analyze water movements, for example those generated by prey fish or by conspecifics. Even the weak water movements left behind by objects that have passed by earlier can be sensed and followed accurately (hydrodynamic trail following). While scanning the water for these hydrodynamic signals at a swimming speed in the order of meters per second, the seal keeps its long and flexible whiskers in an abducted position, largely perpendicular to the swimming direction. Remarkably, the whiskers of harbor seals possess a specialized undulated surface structure, the function of which was, up to now, unknown. Here, we show that this structure effectively changes the vortex street behind the whiskers and reduces the vibrations that would otherwise be induced by the shedding of vortices from the whiskers (vortex-induced vibrations). Using force measurements, flow measurements and numerical simulations, we find that the dynamic forces on harbor seal whiskers are, by at least an order of magnitude, lower than those on sea lion (Zalophus californianus) whiskers, which do not share the undulated structure. The results are discussed in the light of pinniped sensory biology and potential biomimetic applications.

Function: to reduce vibrations

Mechanism: undulated surface structure

Context: while scanning the water for hydrodynamic signals

Organism: harbor seal

Part of: whiskers

Strategy: Harbor seal whiskers reduce vibrations by having an undulated surface structure while scanning the water for hydrodynamic signals.

**Structure of Content**

* Each entry has a
  + Paper Id
  + Summary generated from GPT-3 Da Vinci consisting of
    - Biological Strategy
    - Organism
    - Part of
    - Function
    - Mechanisms
    - Context
  + My notes and analysis

**Content**

1. W2130285640
   * Sample: "title": "Foam nest components of the t\u00fangara frog: a cocktail of proteins conferring physical and biological resilience", "abstract": "the foam nests of the tungara frog (engystomops pustulosus) form a biocompatible incubation medium for eggs and sperm while resisting considerable environmental and microbiological assault. we have shown that much of this behaviour can be attributed to a cocktail of six proteins, designated ranaspumins (rsn-1 to rsn-6), which predominate in the foam. these fall into two discernable classes based on sequence analysis and biophysical properties. rsn-2, with an amphiphilic amino acid sequence unlike any hitherto reported, exhibits substantial detergent-like surfactant activity necessary for production of foam, yet is harmless to the membranes of eggs and spermatozoa. a further four (rsn-3 to rsn-6) are lectins, three of which are similar to fucolectins found in teleosts but not previously identified in a land vertebrate, though with a carbohydrate binding specificity different from previously described fucolectins. the sixth, rsn-1, is structurally similar to proteinase inhibitors of the cystatin class, but does not itself appear to exhibit any such activity. the nest foam itself, however, does exhibit potent cystatin activity. rsn-encoding genes are transcribed in many tissues of the adult frogs, but the full cocktail is present only in oviduct glands. combinations of lectins and cystatins have known roles in plants and animals for defence against microbial colonization and insect attack. tungara nest foam displays a novel synergy of selected elements of innate defence plus a specialized surfactant protein, comprising a previously unreported strategy for protection of unattended reproductive stages of animals."
   * Output:
     + Organism: Túngara frog
     + Part Of: Oviduct glands
     + Function: to form a biocompatible incubation medium for eggs and sperm
     + Mechanism: a cocktail of six proteins
     + Context: while resisting considerable environmental and microbiological assault
     + Strategy: Túngara frogs form a biocompatible incubation medium for eggs and sperm by producing a cocktail of six proteins in their oviduct glands.
   * Notes:
     + Correct
       - Organism, Part Of, Function, Mechanism, Context
     + Incorrect
       - Strategy is missing information.
         * context
     + 5/6
2. W2168114966
   * Sample: "title": "The suctorial organ of the Solifugae (Arachnida, Solifugae)", "abstract": "the ability of members of the arachnid order solifugae to climb smooth, vertical surfaces and the organs involved in this behavior are investigated. macroscopic, microscopic, and scanning electron microscopic observations are made of a palpal organ called the suctorial organ. observations of the behavior but not the microstructure have been made in the past. histological examination illustrates the internal gross anatomy of this structure and scanning electron microscopy demonstrates the fine structure in adults of four genera: eremobates (eremobatidae), eremochelis (eremobatidae), eremorhax (eremobatidae), ammotrechula (ammotrechidae), as well as an unidentified late stage immature and third stage instar. the suctorial organ is most likely primarily used for prey capture in the wild. q 2005 elsevier ltd. all rights reserved."
   * Output:
     + Organism: Solifugae
     + Part Of: Suctorial organ
     + Function: prey capture
     + Mechanism: suction
     + Context: in the wild
     + Strategy: Solifugae use suction to capture prey in the wild
   * Notes:
     + Correct
       - Organism, Part Of, Function, Mechanism, Context
       - Mechanism is abstracted from suctorial organ
     + Incorrect
       - Strategy is missing information.
         * Part Of
     + 5/6
3. W1589686983
   * Sample: "title": "On the Mound of Macrotermes michaelseni as an Organ of Respiratory Gas Exchange", "abstract": "patterns and rates of air movements in the mounds and nests of macrotermes michaelseni were studied using tracer methods. wind is a significant source of energy for powering nest ventilation, despite the mound being a completely enclosed structure. nests are ventilated by a tidal movement of air driven by temporal variation in wind speed and wind direction. density gradients sufficiently steep to drive bulk flow by natural convection will be rare. however, metabolism-induced buoyant forces may interact with wind energy in a way that promotes homeostasis of the mound atmosphere."
   * Output:
     + Organism: Macrotermes michaelseni
     + Part Of: Mound
     + Function: Homeostasis of the mound atmosphere
     + Mechanism: Wind energy
     + Context: Temporal variation in wind speed and wind direction
     + Strategy: The mound of Macrotermes michaelseni is an organ of respiratory gas exchange that is powered by wind energy and maintains homeostasis of the mound atmosphere.
   * Notes:
     + Correct
       - Organism, Part Of, Function, Mechanism, Context
     + Incorrect
       - Strategy is missing information
         * Context
       - Also it adds information that is not part of the main elements extracted.
     + 5/6
4. W1589686983
   * Sample: "title": "A multi-enzyme cascade of hemoglobin proteolysis in the intestine of blood-feeding hookworms.", "abstract": "blood-feeding pathogens digest hemoglobin (hb) as a source of nutrition, but little is known about this process in multicellular parasites. the intestinal brush border membrane of the canine hookworm, ancylostoma caninum, contains aspartic proteases (apr-1), cysteine proteases (cp-2), and metalloproteases (mep-1), the first of which is known to digest hb. we now show that hb is degraded by a multi-enzyme, synergistic cascade of proteolysis. recombinant apr-1 and cp-2, but not mep-1, digested native hb and denatured globin. mep-1, however, did cleave globin fragments that had undergone prior digestion by apr-1 and cp-2. proteolytic cleavage sites within the hb \u03b1 and \u03b2 chains were determined for the three enzymes, identifying a total of 131 cleavage sites. by scanning synthetic combinatorial peptide libraries with each enzyme, we compared the preferred residues cleaved in the libraries with the known cleavage sites within hb. the semi-ordered pathway of hb digestion described here is surprisingly similar to that used by plasmodium to digest hb and provides a potential mechanism by which these hemoglobinases are efficacious vaccines in animal models of hookworm infection."
   * Output:
     + Organism: Hookworm
     + Part Of: brush border membrane
     + Function: digest hemoglobin
     + Mechanism: aspartic proteases, cysteine proteases, and metalloproteases
     + Context: intestinal brush border membrane
     + Strategy: Hookworms digest hemoglobin by using aspartic proteases, cysteine proteases, and metalloproteases in their intestinal brush border membrane.
   * Notes:
     + Correct
       - Organism
       - Part Of
       - Function
       - Mechanism
     + Incorrect
       - Context → not sure, but could be → blood-feeding pathogens
       - Strategy is missing information.
     + 4/6
5. W2052657884
   * Sample: "title": "The Diversity of Hydrostatic Skeletons", "abstract": "a remarkably diverse group of organisms rely on a hydrostatic skeleton for support, movement, muscular antagonism and the amplification of the force and displacement of muscle contraction. in hydrostatic skeletons, force is transmitted not through rigid skeletal elements but instead by internal pressure. functioning of these systems depends on the fact that they are essentially constant in volume as they consist of relatively incompressible fluids and tissue. contraction of muscle and the resulting decrease in one of the dimensions thus results in an increase in another dimension. by actively (with muscle) or passively (with connective tissue) controlling the various dimensions, a wide array of deformations, movements and changes in stiffness can be created. an amazing range of animals and animal structures rely on this form of skeletal support, including anemones and other polyps, the extremely diverse wormlike invertebrates, the tube feet of echinoderms, mammalian and turtle penises, the feet of burrowing bivalves and snails, and the legs of spiders. in addition, there are structures such as the arms and tentacles of cephalopods, the tongue of mammals and the trunk of the elephant that also rely on hydrostatic skeletal support but lack the fluid-filled cavities that characterize this skeletal type. although we normally consider arthropods to rely on a rigid exoskeleton, a hydrostatic skeleton provides skeletal support immediately following molting and also during the larval stage for many insects. thus, the majority of animals on earth rely on hydrostatic skeletons."
   * Output:
     + Organism: anemones, wormlike invertebrates, tube feet of echinoderms, mammalian and turtle penises, feet of burrowing bivalves and snails, legs of spiders
     + Part Of: fluid-filled cavities
     + Function: support, movement, muscular antagonism, and the amplification of the force and displacement of muscle contraction
     + Mechanism: internal pressure
     + Context: animals and animal structures
     + Strategy: animals rely on hydrostatic skeletons for support, movement, muscular antagonism, and the amplification of the force and displacement of muscle contraction by using internal pressure to control the various dimensions
   * Notes:
     + Correct
       - Organism is technically correct, but it should be more general → animals
       - Function
       - Mechanism
       - Part Of is technically Correct, but it should be more general → fluid-filled cavities of the hydrostatic skeleton → hydrostatic skeleton
       - Context
     + Incorrect
       - Strategy abstracted is good, but it is not consistent with what is abstracted.
     + 5/6

|  | Organism | Part Of | Function | Context | Mechanism | Strategy |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| W2130285640 | 1 | 1 | 1 | 1 | 1 | 0 | 5/6 |
| W2168114966 | 1 | 1 | 1 | 1 | 1 | 0 | 5/6 |
| W1589686983 | 1 | 1 | 1 | 1 | 1 | 0 | 5/6 |
| W1589686983 | 1 | 1 | 1 | 0 | 1 | 0 | 4/6 |
| W2052657884 | 1 | 1 | 1 | 1 | 1 | 0 | 5/6 |
|  | 5/5 | 5/5 | 5/5 | 4/5 | 5/5 | 0/5 |  |

* Conclusion
  + Much improved prompt, should try with more samples
  + Possibly make another prompt to combine each individual part abstracted
  + Strategies produced
    - W2130285640
      * Túngara frogs form a biocompatible incubation medium for eggs and sperm by producing a cocktail of six proteins in their oviduct glands.
        + Strategy is missing information.

Context: while resisting considerable environmental and microbiological assault

* + - W2168114966
      * Solifugae use suction to capture prey in the wild
        + Strategy is missing information.

Part Of: Suctorial organ

* + - W1589686983
      * The mound of Macrotermes michaelseni is an organ of respiratory gas exchange that is powered by wind energy and maintains homeostasis of the mound atmosphere.
        + GPT adds information that is not part of the main elements extracted.
        + Strategy is missing information.

Context: Temporal variation in wind speed and wind direction

* + - W1589686983
      * Hookworms digest hemoglobin by using aspartic proteases, cysteine proteases, and metalloproteases in their intestinal brush border membrane.
        + Context extracted may be incorrect

Context: intestinal brush border membrane

not sure, but could be → blood-feeding pathogens

* + - * + Strategy is missing Context, since it could be correct.

Context → while resisting considerable environmental and microbiological assault

* + - W2052657884
      * animals rely on hydrostatic skeletons for support, movement, muscular antagonism, and the amplification of the force and displacement of muscle contraction by using internal pressure to control the various dimensions
        + Strategy abstracted is good, but it is not consistent with what is abstracted.