# Champion Cheatsheets Division B/C

Georgia Tech Event Workshop Series 2024-25



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## **Cheatsheet Rules**

- Check your event rules sheet for cheatsheet rules under "Event Parameters"!
- Typical Cheatsheet Rules:
  - 8.5" x 11" (Letter size)
  - Usually 1 sheet per team
  - Front & Back
  - Cannot affix additional labels to the cheatsheet to increase surface area
  - May be laminated / sealed in protector



#### MICROBE MISSION C



DESCRIPTION: Teams will answer questions, solve problems, and analyze data pertaining to microbes. ATEAM OF UPTO: 2 EYE PROTECTION: C

CALCULATOR: Class II

APPROXIMATE TIME: 50 minutes

- EVENT PARAMETERS: For events with a lab practical portion, each student must wear goggles. Each team may bring one 8.5" X 11" sheet of paper, which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with two stand-alone non-programmable, non-graphing calculators (Class II). Any measurements must be made to the precision of the device.
- THE COMPETITION: This Event may be administered as a written test or as a series of lab-practical stations which can include but are not limited to experiments, scientific apparatus, models, illustrations, specimens, data collection and analysis, and problems for students to solve. Participants may be asked to perform simple laboratory procedures such as taking measurements using a microscope or using probes to collect data (sufficient information will be provided at the station to do so). Questions should emphasize process skills such as quantitative reasoning, making calculations, analyzing and interpreting experimental results, and drawing evidence-based conclusions. The Event will cover the topics listed below without any overemphasis on any one particular topic. The list of topics is exhaustive.
- a. For each of the following topics, participants will be expected to use quantitative reasoning and computational skills, analyze and interpret experimental results, and draw evidence-based conclusions.
  - (1) Describe the parts, functions, images, and sample preparation of bright-field, phase contrast, fluorescence, and electron (TEM & SEM) microscopes.
  - (2) Identify and explain which microscopy method is most appropriate to address a given hypothesis or experimental goal.
  - (3) Estimate the size of microbes using scale bars. Calculate magnification and resolution using power and numerical aperture data. Determine direct cell counts (in cells/ml) using a Neubauer counting chamber (exact chamber dimensions to be provided by the Exam writer). Structure and Morphology:
  - (1) Describe the basic structure, composition, and function of components of bacterial, archaeal, and eukaryotic (i.e., microalgal and fungal) cells (i.e., membrane, cell wall, flagella, pilus, fimbria, nucleoid, cytoplasm, and organelles) and of specialized structures in bacteria and eukaryotic microbes (i.e., gas vesicles, endospores, contractile vacuoles, eyespots,
  - (2) Contrast Gram (+), Gram (-), and acid-fast cells and explain the Gram stain procedure. (3) Describe basic structural components of viruses and their functions
- (4) State and Nationals only: Describe different forms of cell locomotion (swimming and gliding motility) and discuss chemotaxis and phototaxis.
- iii. Culture and Growth: (1) Describe applications of different methods to culture bacteria (i.e., liquid vs. agar) and different
- media used to do this (i.e., selective vs. differential).
- (2) Interpret bacterial growth curves and discuss what is happening at each stage. (3) Describe how plate count data (i.e., CFUs) and optical density measurements are used to calculate the number of cells in a culture and population growth rate.
- (4) Describe how major classes of antibiotics (i.e., penicillins, tetracyclines, beta-lactams, cephalosporins, and fluoroquinolones) target bacterial growth. State and Nationals only: Describe mechanisms of bacterial resistance to these antibiotic classes.
- (5) Describe how sterilization and disinfection techniques (i.e., heat, ultraviolet radiation. filtration, and chemical) are able to compromise/eliminate microbes.
- (6) Understand the limitations of culture-based approaches to study microbes.
- (1) Outline the steps of bacterial cell division (i.e., binary fission) and genome replication, including the function and properties of the origin of replication, DNA unwinding element, DnaA, and DNA polymerase. State and Nationals only: Outline the steps of rolling circle replication and identify microbes or agents that use this strategy
- (2) Outline the steps of bacterial transcription and translation, including major enzymes involved.

## **Binder Rules**

- Check your event rules sheet for binder rules under "Event Parameters"!
  - Binders may be one per team or one per participant
  - Some events have binder size limits of 2", some events have no limit
  - Some events do not let you remove pages from binder during the event
- Material should be secured onto the binder using sheet protectors or through hole-punch
- Sheet protectors, laminations, tabs, and labels are typically allowed



# General Tips - Formating Cheatsheets

- Include as much information as possible, but keep it readable
  - Decrease font size, decrease margins
  - Utilize highlighting and bolding
  - Eliminate articles (the, a, etc.)
  - $\circ$  Abbreviate common words (ex: because  $\rightarrow$  bc)
  - $\circ$  Abbreviate content words if you know them (ex: hydrochloric acid  $\rightarrow$  HCl)
- For events with labeling (ex: A&P), include diagrams
  - May be helpful to draw your own diagrams! Decreasing size of diagrams
     make words hard to read due to lower image resolution
  - Print in color, if available

# General Tips - Formating Cheatsheets

- Organize content by topic
  - Try to group similar information together or sequentially so that it is easier to find during your event
- Don't write every single piece of information you will run out of space
  - Exclude simple content that you can easily study
- Know what kind of information you need
  - o Graphs, images, vocabulary, labeled diagrams, equations/formulas
- Hand-write / label additional information into margins after printing
- Print multiple copies just in case!
- Bringing sheet protector can help prevent soggy/wrinkled cheatsheets

# General Tips - Google Docs

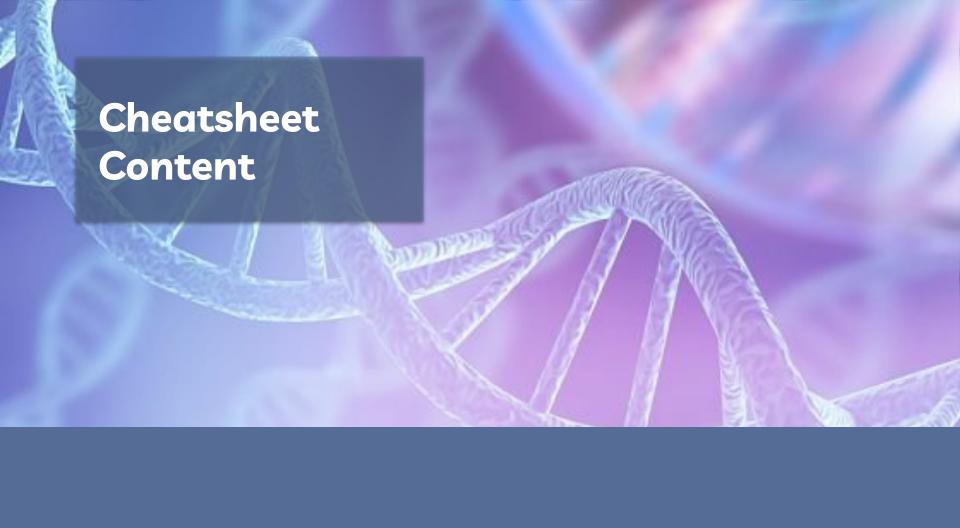
- Google docs is commonly used to create cheatsheets (easy to collaborate!)
- Other: microsoft word, canva, OneNote, etc.

### Google Docs - Changing Formatting

- Adjusting Margins: files → page setup → margins
- Adjusting Orientation: files → page setup → orientation
- Making Columns: format → columns
- Adjusting Image Margins: select image  $\rightarrow$  wrap text  $\rightarrow$  adjust margins
- Play around to figure out what works best for your team

# General Tips - Formating Binders

- Binders are much larger than a single cheatsheet
  - You can include much more detailed, thorough information
  - Organization is crucial
- Create a table of contents for your binder, use page numbers
- Use tabs to easily find sections
- Highlight main points, definitions
- Compile your resources in google drive and print ahead of time
  - Hole-punching and organizing takes time



## Content

- Event topics can be found on your Event Rules sheet under "The Competition"
- Read the topics that are included in your level of tournament
  - There may be more topics included in a state competition than regional
- Check for additional resources you can bring
  - Field guides, national lists



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  - (5) Describe how sterilization and disinfection techniques (i.e., heat, ultraviolet radiation, filtration, and chemical) are able to compromise/eliminate microbes.
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  - Molecular Biology:
  - Outline the steps of bacterial cell division (i.e., binary fission) and genome replication, including the function and properties of the origin of replication, DNA unwinding element, DnaA, and DNA polymerase. State and Nationals only: Outline the steps of rolling circle replication and identify microbes or agents that use this strategy.
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## Content

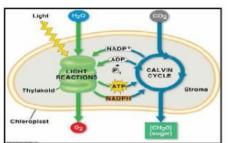
- For both binder and cheatsheet events, it is best if you have a general understanding of content
  - Your resource should serve as a supplemental
- Read your topics to see what type of information would be useful in your resource, for example:
  - A&P labeled diagrams
  - Fossils lists, pictures, details, dichotomous key
  - Chemistry formulas, rules

## Content

- Where to gather content?
  - Studying general content knowledge: Khan academy, youtube, simple google searches
  - Detailed content: textbooks, manuals, nationally published resources
- Ask your coach and teammates
  - There may be resources previous students at your school may have used
- Science Olympiad website: event-specific links to resources, practice exams



# Examples



electron and fill the "energy vacuum" that

been created. This is a process humans haven't been able to replicate exactly in a

Each water molecule breaks down into

-oxygen atoms from disassembled water

form oxygen gas (O2). The hydrogen ions

in the lumen of the thylakoid. They pass

form ATP (adenosine triphosphate). This

powers many cellular processes. In fact,

photosystem II arrives at photosystem I, chlorophyll. Energy from the sun excites

cellular respiration. Meanwhile, the

enough energy to pass across the

create the energy-carrying molecule

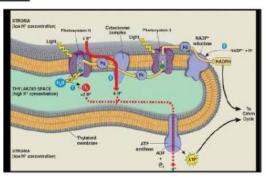
photosynthesis is broken down to produce

one oxygen (O) atom. The oxygen is

ATP synthase, and their movement

to add a third phosphate to ADP

Photosynthesis: The goal of the light-dependent reactions of photosynthesis is to collect energy from the sun and break down water molecules to produce ATP and NADPH. These two energy-storing molecules are then used in the light-independent reactions. Within chloroplasts, chlorophyll is the pigment that absorbs sunlight. It is stored in the thylakoid membranes in protein complexes called photosystem II and photosystem II. The series of light-dependent reactions begins when sunlight hits a molecule of chlorophyll, located in photosystem II. This excites an electron, which leaves the chlorophyll molecule and travels along the thylakoid membrane via a series of carrier proteins (known as the electron transport chain). Then, something amazing happens—photosystem II splits a water molecule to restore this lost



two hydrogen (H) atoms and released as a waste product molecules join up in pairs to build up in high concentration through an enzyme called provides the energy needed (adenosine diphosphate) to energy-storing molecule the glucose made during more ATP later, during electron released from which also contains

has

the electron again, giving it membrane and into the stroma, where it joins NADPH. ATP and NADPH move from the thylal

store is used to power the light-independent reactions. The ultimate goal of the light-independent reactions (or Calvin cycle) is to assemble a molecule of glucose. This is the part plant gets from the air. Essentially, the plant needs the carbon from the CO2 to create the building blocks for glucose. An enzyme in the stroma called rulisCo combines a five-carb biphosphate) with a molecule of carbon dioxide. This creates a six-carbon molecule that is broken down into two three-carbon molecules (3-phosphoglycerate). This part of the light carbon fixation. Then, the energy carriers from the light-dependent reactions make their contribution. ATP and NADPH give each 3-phosphoglycerate a hydrogen atom, creating to (glyceraldehyde-3-phosphate). Ultimately, these two molecules of G3P are used to build one molecule of glucose. This part of the light-independent reactions is typically referred to because electrons are added. It is important to note that the Calvin cycle typically uses six molecules of carbon dioxide at a time. This means that twelve molecules of G3P are gen to produce a molecule of glucose—the rest are recycled back into RubP so that the cycle can keep running.

Great use of diagrams highlighting, bolding

Word organization could be improved, better sectioned for easier reading

# Examples

to be entired by being the prince of the first, wedstern in the principal state. professivelythis conversal bearing better as fainful invarial part of the hangered byte.

No was finding Travel I do a recognition for construction for the other property and provided in the construction and provided in the construction of the construction of the construction of the first construction of the constr A can result or arriver personality changes. Requirely in companying from Time man because ance constitute up must be for the contract of the consequences remitting their minimal continue of the a principal principal field and a princip come Disease & realise or to Direct via Parties In the proper later according to the proper late county workshop and an equation delither. It is also accommunity the reference of contrastion of Contrastic Co equals introduce to be also and broad it to provided protour to the central decreases and decrease occurs and make occurs, the excellent year hand to collect the central decreases and occurs on the central decr often and framely de formal from the superior from gazing access. The access are not to the contract of the formal from the contract of the superior from gazing access. The access are not to the first on the property of the formal deposition of the superior of the first of the former the four-tier is the range year of the range some of the range some of the range of the r promise or the contraction control than the fact of the court flagrant follows recovered by the court of the c recipios proving to all and soft and mindraley language if a control acceptance and real feature service have related to a feature acceptance and recipion and a control acceptance and a control ac to be followed by the control of the the first and compared the forms Continued Design Transaction for the continued of the form the Continued Design Transaction for the continued of the continued Design Transaction for the Continued Design Transaction Transa was further include thought and action. Sin divided are our rection, radial disput recome. Supportions, multiple the bod's failth on fight recome. There are 3 Conditions for this Compan, in a force, druit recome. Now Yours the partial bits compatible and impositive families at the partial format from the partial of the partial between A sale at legal when private as the partial of the partial between the partial of the partial between A sale at legal when private as the partial between the part manage the set of these and were applicable to the second properties of and the content and the property of the large of the content of th regard, Library districts distribute and a fundamental and the look distribute and a fundamental and a gill beautient. Medy financials be part of it on different fight, a gibbar the properties, service or one it action to the planta and company public you convertedly the controller. replace a second of the court, and supplied a second state of the court of the cour differ Cappe administration from the former than comments of the comments of t Table to contain Consent for adventure next service once (CD), as unwide, durant other percent repetition in the percent of th again become de de certeir auf nibe part af de tech stal la participa. De control de certeir de certeir auf nibe personal de certeir oper the full of the medium of large of the contract of the potential property of the contract talms. Other can be control. Region have present in Bladte Super the Americanucia, and gladt which the body in a destination of the control o

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(I apologize for image resolution)

Color coding topics like this can be an easy way to locate information. Writing in columns can be easier to read.

# **Examples (My Personal Cheatsheet!)**

#### Complex Carbohydrates (CHO)

Starch - plant energy storage, easily digested. Tested for with jodine. Hydrophilic

Glycogen - animal short term energy storage Cellulose - fiber, wall of plants, algae Chitin - wall of fungi, exoskeleton of arthropods

#### Glucose detected by Benedict's test. 3 Main Lipid Types (CHO)

Triglyceride - glycerol + 3 fatty acids, long term energy storage, main fat in animals

Phospholipid - cell membrane Steroid - lipid w/ ring structure core of 17 C

Tested for with Sudan III test.

#### Proteins (CHONS)

- 1 polypeptide chain w/ covalent peptide bonds
- a-helix most common, -NH group & -CO interact

B-pleated sheet - stretched, then intermol H bond

3 - H-bonds, electrostatic forces, disulphide linkages, and Vander Waals: give 2 shape: Fibrous - long narrow, structural role

Globular - compact round, functional role 4 - tertiary structure interact and arrange

Tested for with Biuret stain. Nucleic Acid (CHONPS)

DNA rep: initiation, elongation, termination Post-Translational Modifications Phosphorylation - protein; critical for cell process Glycosylation - protein; cell surface receptors Ubiquitination - protein; marks for degradation Proteolytic cleavage - may activate/inhibit/destroy

Photorespiration: occurs when rubisco acts on oxygen rather than carbon dioxide

- \* rice, wheat, sovbeans, all trees (cool, wet) \* In mesophyll: CO2 fixation by rubisco → 3 carbon compound
- \* tropical grass, sugarcane, corn (hot, sunny)
- \* light dependent reaction and Calvin cycle is separate | Telomerase: extends telomeres, usually active in germ | \* ATPase called NSF and other cofactors use ATP
- LD reaction: mesophyll - Calvin cycle: bundle sheath (BS)
- \* In mesophyll: CO2 oxaloacetate by PEP

- \* transmembrane proteins; span the entire membrane G-protein linked; (aka heptahelical receptor) \* peripheral protein: loosely bound to surface of membrane or to part of integral protein. Not embedded interacts with nearby membrane protein
- in lipid bilayer. \* glycolipid: cellular recognition
- qlycoprotein: receptors for chemical signals aguaporin: type of channel protein that specifically
- facilitates diffusion of water \* tonicity: ability of surrounding solution to cause a cell
- to gain or lose water \* sodium-potassium pump: 3 Na+ out. 2 K+ in.
- Maintains negative charge inside cells. \* most permeable to K+ ions.

Necrosis: accidental cell death

- 2 H bonds b/w carbonyl & amino groups that make up Apoptosis: programmed cell death. Intrinsic: non-receptor-mediated
  - extrinsic: receptor-mediated
  - to be released by mitochondria. Caspases dismantle Inactivation of FAK ---> detachment of apoptotic cell.
  - Tumor necrosis factor is an extracellular messenger of RabGDP is the inactive form, GEF proteins make
  - BCI-2 regulates the intrinsic pathway of apoptosis.
    - 1. cell shrinks and blebs
  - 2. cell components broken down by proteins
  - to attract macrophages
  - 4. Cell breaks into smaller pieces
  - 5. Macrophage find & engulf apoptotic cell fragments \* Caspases: proteases & nucleases (chop things up)
  - Transformation: process by which cell acquires ability to divide indefinitely
  - Hel a cells: "immortal"
  - Benian tumor: cells remain at original tumor site Malignant: cells can invade and survive on other sites Metastasis: spread of cancer cells from origin to another location
  - Angiogenesis: growth of new blood vessel Telomere: 5'-TTAGGG-3'
  - cells, but also active in cancer cells. Cancer immortality, hydrolysis to release the binded v-SNARE from When cancer cells are grown in culture they do not form monolayers.
- carboxylase ... oxaloacetate → malate (final product) Tumor suppressor gene p53 regulates G1 to S trans.

when ligand binds, activates a G-protein, which then

- all have seven transmembrane domains, but each receptor has specific extracellular domain and G-protein binding site
- \* G proteins have three subunits: a. B. v. In resting state, aBy is bound together with GDP attached to a. when GPCR is activated, it exchanges GTP for GDP in the protein. The subunit w/ GTP dissociates from B-v dimer.
- \* a-GTP can bind with effector enzymes \* B-v dimer can activate ion channels and kinases

#### Lipid Raft

- \* segments of plasma membrane that contain high concentrations of cholesterol, glycosphingolipids, saturated phospholipids
- Controlled by p53 gene, which codes for cytochrome c \* causes tight packing, insoluble w/ nonionic detergent Vesicles: Fusion
  - \* RabGTPase: family of proteins that regulate vesicle transport and docking
  - RahGDP → RahGTP which is then active
  - some Rabs bind to vesicle membrane and some bind to target membrane
- after binding to membrane, they recruit Rab effector proteins, which assist in vesicle transport and docking 3. enzymes break down nucleus and cell emits signals -- motor adaptors: form link between vesicles and motor proteins
  - -- tethering factors: assist in docking
  - \* fusion of membranes is highly unfavorable and only happen when membranes are brought together few nanometers close
  - \*SNAREs: proteins that help do this. This also allows
  - once vesicle docked, v-SNARE (anchored to vesicular membrane) coil with t-SNARE (anchored to target membrane)
  - \* this coiling tightens gap between vesicle and target membranes, causing membranes to form a hemifuse (highly unstable), then flatten out. \* RabGTP is made inactive by GAPs protein

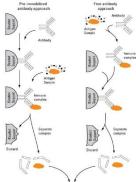
#### Vesicles: Formation

- GEF proteins activate GTPase, which binds to

enzyme to achieve half Vmax.

#### Velocity of rxn = (Vmax\*[S])/(Km + [S])

- 1 gel electrophoresis to separate proteins
- 2 membrane transfer of separated proteins 3 immunodetection of target protein w/ antibody
- 1 Coating antigen is absorbed onto well in ELISA plate in coating buffer
- 2 Blocking buffer containing unrelated protein is used NADP+ + H2O. to block free sites in the wells
- 3 Detection enzyme conjugated detection antibody
- 4 Readout substrate is catalyzed by enzyme to generate colored readout Immunoprecipitation
- \* to precipitate protein out of a solution using antibody



- IP vs Co-IP
- \* IP specific target/antigen is purified \* Co-IP - target antigen w/ binding partners purified

Km is the concentration of substrate which permits the \_-MPF is activated at the end of the G2 phase by an enzyme phosphatase. It is made from three parts such as a kinase, a cyclin, and a phosphate group. It can be inactivated by destroying a protein called cyclin. The function is to promote spindle assembly, chromatin condensation and the breakdown of the nuclear envelope. Starts metaphase.

#### Photosynthesis:

LDR: H2O + ADP + NADP+ -> O2 + ATP + NADPH Independent: 2 NADPH + 3 ATP + CO2 -> G3P + 2

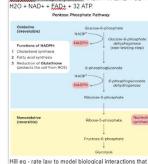
#### Cellular respiration:

Glycolysis: Glucose + 2 ATP + 2 NAD+ -> 2 Pyruvate + 4 ATP + 2 NADH

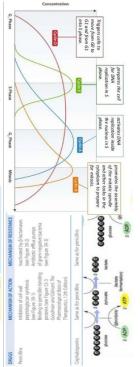
Fermentation: 2 ethanol or lactic acid produced. If ethanol, 2 CO2 also produced.

Oxidation of Pyruvate: Pyruvate + NAD+ + Acetyl group + Coenzyme A -> Acetyl CoA + NADH + CO2. Krebs Cycle: Acetyl CoA + 3NAD+ + FAD -> 3NADH + FADH2 + ATP

#### Oxydation Phosphorylation: NADH + FADH2 + O2 -> H2O + NAD+ + FAD+ + 32 ATP.



Hill eq - rate law to model biological interactions that demonstrate sigmoidal response



# Examples

Ultimately, these are just examples and tips on how you can structure your cheatsheet or binder.

Work with your partner, your team, and coach to build your resource that works best for you.



# Tips from a Veteran

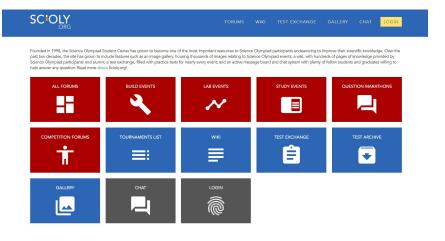
- Split up event topics with your partner
  - Focusing more deeply on smaller number of topics can be helpful
- Try to study and understand the general information within a topic, putting more complex, detailed, difficult to memorize parts of information on the cheatsheet
- Know your cheatsheet!
  - It is inefficient to continuously search for where you wrote information

# Tips from a Veteran

- Check your printed cheatsheet
  - Make sure things did not get cut off (personal experience are visible
  - Things may look fine on computer and get distorted when printing
- Collaborate and work together with your team and coach
- Learn and have fun!

## **Resources to Check Out**

## Scioly.org



## Soinc.org

#### MICROBE MISSION

Welcome to Microbe Mission! In this event, teams will answer questions, solve problems and analyze data pertaining to microbes.

The information below should not be interpreted as an extension of the rules. You can find free online copies of the current rules for download on the 2025 Rules page of the Science Olympiad website. The official rules in the current Rules Manual take precedence.

#### **RESOURCES & LINKS**

- · American Society for Microbiology Education Resources
- Open Educational Resources Microbiology
- . BioEd Online Teacher Resources
- . Curated Microbe Mission resources from our friends at LabXchange > Excel download
- · Open Textbook Library: "Microbiology"
- · Online virtual microscopy lab
- . Harvard Microbial Sciences Initiative K-12 Microbiology resources
- . HHMI Biointeractive Winogradsky Column
- . The Joyful Microbe: Science Blog & Educational Activities
- 2018 Power Point
- 2018 th Internet Resources
- 2018 Microscopy Review
- 2018 7 Training Handout
- 2017 Training Handout
- . 2017 Training Handout Microscopy
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- 2017 Training Handout Industry
- 2017 the Training Handout Groups
- 2017 Training Handout Ecology



Microbe Mission Champions at the 2024 National Tournament

# THANKS!

