

**MUSHROOM POISONING:**

- Pediatric exposures
- At risk patients:
  - Foragers (inexperienced, foodies, immigrants)
  - Experimenters

**LIMITATIONS OF IDENTIFICATION:**

- Correct identification (genus or species level) is difficult
- The edibility (toxicity) may not be known
  - > 10,000 described species worldwide
    - Toxicity confirmed for ca. 100 species
    - Edibility *claimed* for ca 2,000 species
    - Individual variation in response to some mushrooms
    - Variation in toxin content depends on geography, conditions, etc
  - Approx. 1900 described species in SW BC

**MUSHROOM BIOLOGY:**

- Mushrooms are the above-ground fruiting body (spore-producing reproductive structure) of fungi
- Only appear where and when conditions are right (not always annual)
  - More than one species can grow in a given location
  - Territory may change
- Species may have specific preferred habitats
  - Disturbed soil, compost, duff, dead trees
  - Some have specific mycorrhizal associations (symbiotic relationships with the root systems of certain trees/plants)

**MUSHROOM IDENTIFICATION:**

- Seasonal appearance
- Habitat (what kind of substrate, tree associations, etc)
- Physical characteristics
- Identification guides and keys
  - Visual identification guides for common, distinct species
  - Dichotomous ID keys (if this, then that) for more complete/detailed/ complicated identification work

**MUSHROOM PHYSICAL CHARACTERISTICS:**

- Spore print (for spore color)
  - Most toxic mushrooms (*Amanitas*, *Lepiotas*) = white spores!
- Smell, taste, bruising/staining, peelability
- Fleshy characteristics (brittle, flexible, fibrous, etc)

**SYNDROME CLASSIFICATION:**

- Clinical manifestations
- Time to onset of initial symptoms

**CAVEATS:**

- Time to onset of symptoms has a range
- Syndromic classification can be confounded by:
  - Ingestion of more than one type of mushroom
  - Staggered ingestions (eaten ≥ 2 consecutive meals)
  - Co-ingestants
  - Contamination (pesticides, microbes, heavy metals)

**SYNDROMES:**

<b>EARLY-ONSET (&lt;4 hrs)</b>	<b>GI IRRITANT</b>	<ul style="list-style-type: none"> <li>• Numerous</li> </ul>
	<b>NEUROTOXIC</b>	<ul style="list-style-type: none"> <li>• Muscarine</li> <li>• Ibotenic acid/muscimol</li> <li>• Psilocybin</li> </ul>
	<b>DISULFIRAM-LIKE</b>	<ul style="list-style-type: none"> <li>• <i>C. atramentarius</i></li> </ul>
	<b>RHABDOMYOLYSIS</b>	<ul style="list-style-type: none"> <li>• <i>R. subnigricans</i> *</li> </ul>
<b>LATE-ONSET (6-24 hrs)</b>	<b>IMMUNOHEMOLYTIC SYNDROME **</b>	<ul style="list-style-type: none"> <li>• <i>Paxillus involutus</i></li> </ul>
	<b>HEPATOTOXIC</b>	<ul style="list-style-type: none"> <li>• Cyclopeptide</li> </ul>
	<b>GI → SEIZURES</b>	<ul style="list-style-type: none"> <li>• Gyromitrin (monomethylhydrazine)</li> </ul>
<b>DELAYED-ONSET (&gt; 24 hrs)</b>	<b>NEPHROTOXIC</b>	<ul style="list-style-type: none"> <li>• <i>A. smithiana et al.</i></li> </ul>
	<b>RHABDOMYOLYSIS**</b>	<ul style="list-style-type: none"> <li>• <i>T. equestris</i></li> </ul>
	<b>NEPHROTOXIC</b>	<ul style="list-style-type: none"> <li>• <i>Cortinarius spp.</i> *</li> </ul>
	<b>ERYTHROMELALGIA**</b>	<ul style="list-style-type: none"> <li>• <i>Clitocybe spp.</i></li> </ul>
	<b>NEUROTOXIC**</b>	<ul style="list-style-type: none"> <li>• <i>Hapalopilus rutilans</i></li> </ul>

\* rare or unconfirmed cases in N. America    \*\* cases not reported in N.

**EARLY ONSET:**

**GI IRRITANTS:**

<b>INFO</b>	<ul style="list-style-type: none"> <li>• Numerous species, various possible mechanisms</li> <li>• 2<sup>nd</sup> most common form of mushroom poisoning reported in US (after psilocybin)</li> <li>• Typical onset of symptoms = mins – 4 hours                     <ul style="list-style-type: none"> <li>◦ Usually self-limiting</li> </ul> </li> </ul>
<b>TXT</b>	<ul style="list-style-type: none"> <li>• Maintain fluid &amp; electrolyte balance</li> <li>• Avoid antidiarrheal &amp; antispasmodic drugs</li> </ul>
<b>HX</b>	<ul style="list-style-type: none"> <li>• Time of ingestion</li> <li>• Amount ingested</li> <li>• How many types of mushrooms eaten</li> <li>• If anyone else has eaten and symptomatic</li> <li>• Mushrooms consumed at &gt; 1 consecutive meal</li> <li>• Co-ingestants</li> </ul>
<b>NOTES</b>	<ul style="list-style-type: none"> <li>• If symptom onset &gt; 4 hours post-ingestion, every effort should be made to identify mushrooms                     <ul style="list-style-type: none"> <li>◦ Further monitoring including labs may be warranted</li> </ul> </li> <li>• <i>A. smithiana</i> can sometimes cause GI sx &lt; 4 hours</li> </ul>

**NEUROTOXIC:**

<b>MUSCARINE</b>	<b>INFO</b>	<ul style="list-style-type: none"> <li>• <i>Clitocybe spp.</i>, <i>Inocybe spp.</i></li> </ul>
	<b>MOA</b>	<ul style="list-style-type: none"> <li>• Binds to muscarinic receptors → peripheral cholinergic effects</li> </ul>
	<b>S/S</b>	<ul style="list-style-type: none"> <li>• Vomiting &amp; diarrhea w/in 2 hrs of ingestion</li> <li>• Followed by perspiration, hypersalivation, miosis, shivering and bradycardia</li> <li>• Mostly self-limiting, but fatalities reported</li> </ul>
<b>IBOTENIC ACID/ MUSCIMOL</b>	<b>TXT</b>	<ul style="list-style-type: none"> <li>• Atropine for moderate to severe symptoms</li> </ul>
	<b>INFO</b>	<ul style="list-style-type: none"> <li>• <i>Amanita muscaria</i></li> <li>• <i>A. pantherina/pantherinoides</i></li> <li>• Others</li> </ul>
	<b>MOA</b>	<ul style="list-style-type: none"> <li>• Ibotenic acid resembles glutamic acid → glutaminergic stimulation</li> <li>• Decarboxylated to muscimol → inhibitory</li> </ul>
	<b>S/S</b>	<ul style="list-style-type: none"> <li>• GI upset, dizziness, ataxia, CNS excitation</li> <li>• Followed by CNS depression, seizures, myoclonus jerking</li> <li>• Death is rare (status epilepticus, aspiration)</li> </ul>
	<b>TXT</b>	<ul style="list-style-type: none"> <li>• Mainly symptomatic and supportive</li> </ul>

**DISULFIRAM-LIKE:**

<b>INFO</b>	<ul style="list-style-type: none"> <li>• <i>Coprinopsis atramentarius</i> (inky cap) and some other <i>Coprinus</i> species BUT NOT <i>C. comatus</i> (shaggy mane)</li> </ul>
<b>MOA</b>	<ul style="list-style-type: none"> <li>• Metabolites of AA coprine inhibit aldehyde dehydrogenase</li> <li>• Edible, but if alcohol is consumed → acetaldehyde accumulation and “disulfiram-like reaction”                     <ul style="list-style-type: none"> <li>◦ Alcohol before mushrooms → delayed (30-120 min)</li> <li>◦ Alcohol after mushrooms → rapid reaction</li> </ul> </li> <li>• Reaction may occur for 3-5 days after mushroom ingestion</li> </ul>

**LATE ONSET:**

**GYROMITRIN:**

<b>INFO</b>	<ul style="list-style-type: none"> <li><i>Gyromitra spp. (G. esculenta, G. infula)</i></li> <li>Sometimes mistaken for morels</li> <li>European spp up to 10x gyromitrin of N. American spp</li> <li>Poisoning uncommon west of Rockies</li> </ul>
<b>MOA</b>	<ul style="list-style-type: none"> <li>MMH causes hepatotoxicity</li> <li>Also inhibits pyridoxine-dependent production of GABA</li> </ul>
<b>SX</b>	<b>INGESTION (5-12 h)</b> <ul style="list-style-type: none"> <li>NVD, cramping, HA, weakness, vertigo, delirium, seizures (rare), hepatotoxicity</li> <li>Hemolysis in 1-3 days with renal injury</li> </ul>
	<b>VAPOURS</b> <ul style="list-style-type: none"> <li>Eye and m/m irritation</li> <li>Systemic toxicity with faster onset (2-8 h)</li> </ul>
<b>TXT</b>	<ul style="list-style-type: none"> <li>Mainly symptomatic and supportive</li> <li>Pyridoxine 25 mg/kg IV recommended for seizures, in addition to benzos</li> </ul>

**NEPHROTOXICITY:**

<b>INFO</b>	<ul style="list-style-type: none"> <li><i>Amanita smithiana</i> – often confused for pine mushroom</li> </ul>
<b>MOA</b>	<ul style="list-style-type: none"> <li>Toxin(s) responsible not known</li> </ul>
<b>SX</b>	<ul style="list-style-type: none"> <li>Onset of GI sx (N/V) generally <math>\geq 5</math> hours, but has been reported as early as 20 minutes (raw)</li> <li>Followed by renal dysfunction over ensuing 1-7 days</li> <li>Moderately elevated ALT &amp; LDH may be seen early on</li> </ul>
<b>TXT</b>	<ul style="list-style-type: none"> <li>Mainly symptomatic/supportive care &amp; dialysis (9-180 d)</li> <li>Role of NAC for mild hepatotoxicity not established</li> <li>All known pts so far have recovered renal function!</li> </ul>

**CYCLOPEPTIDE:**

<b>INFO</b>	<ul style="list-style-type: none"> <li><i>Amanita phalloides</i> (death cap) <ul style="list-style-type: none"> <li>Deadliest mushroom of all</li> <li>Found most often in Vancouver &amp; Victoria in urban settings, also in Fraser Valley &amp; Gulf Islands</li> <li>Grows in association with hornbeam (<i>Carpinus</i>), beech, chestnut, hazelnut and oak</li> </ul> </li> <li><i>Conocybe spp., Galerina spp., Lepiota spp</i> <ul style="list-style-type: none"> <li><i>Galerina spp.</i> least toxic</li> </ul> </li> </ul>
<b>MOA</b>	<b>AMATOXINS</b> <ul style="list-style-type: none"> <li><math>\alpha</math>-amanitin <math>\rightarrow</math> inhibits RNA polymerase, stops protein synthesis</li> <li>amatoxins taken up by liver via OATP, undergoes enterohepatic cycling and renal elimination</li> </ul>
	<b>PHALLOTOXINS</b> <ul style="list-style-type: none"> <li>Phalloidin <math>\rightarrow</math> poorly absorbed but causes GI toxicity</li> </ul>
<b>S/S</b>	<b>PHASE 1</b> <ul style="list-style-type: none"> <li>Initial GI toxicity 6-24 h post-ingestion (cramping, abd. pain, vomiting, watery diarrhea, dehydration)</li> </ul>
	<b>PHASE 2</b> <ul style="list-style-type: none"> <li>Apparent recovery but asymptomatic liver damage occurring with rapid rise in transaminases (peak 3-4 days)</li> <li>Coagulopathy</li> </ul>
	<b>PHASE 3</b> <ul style="list-style-type: none"> <li>By 72 hours GI sx recur</li> <li>hepatic tenderness, jaundice, hypoglycemia, encephalopathy, renal failure, pancreatic insufficiency</li> <li>death may occur within 7 days</li> </ul>
<b>TXT</b>	<ul style="list-style-type: none"> <li>GI decontamination if recent ingestion</li> <li>Amatoxin elimination <ul style="list-style-type: none"> <li>Aggressively maintain euolemia</li> <li>Interrupt enterohepatic cycling (multiple dose charcoal, NPO, octreotide, biliary drainage)</li> </ul> </li> <li>Block uptake of amanitins into liver cells <ul style="list-style-type: none"> <li>Silibinin (IV extract from milk thistle), high-dose penicillin, other OATP inhibitors (cyclosporins)</li> </ul> </li> <li>Protect RNA polymerase from attack by amanitins <ul style="list-style-type: none"> <li>High dose penicillin, polymyxin B (animal data)</li> </ul> </li> <li>NAC = no proven benefit, but may decrease progression of hepatic encephalopathy, nephropathy &amp; coagulopathy</li> </ul>

**POISONOUS MUSHROOM FALLACIES:**

- Poisonous mushrooms do not turn silver objects black
- Poisonous mushrooms do not turn onions, garlics, or rice a particular color
- Poisonous mushrooms do not taste bad
- Just because insects, slugs, and other animals eat it doesn't mean a mushroom is safe to eat

**POISONOUS MUSHROOM TRUTH:** every mushroom is edible ... once!

**SAFE MUSHROOM CONSUMPTION:**

- Join a club
- Learn from knowledgeable members
- Get to know the local edibles
- Eat in moderation

**SUMMARY:**

- Mushroom identification is difficult in many cases
  - Toxicity can vary within a genus (ex// *Amanita* spp.)
- Unintentional exploratory ingestion by kids is generally benign
  - Rule out *Amanita phalloides*
- Toxidromes, time to onset, and careful history taking can be used to classify mushroom poisoning
  - Beware ingestions of multiple species, repeated/staggered intake
- Most patients just need good symptomatic/supportive care
- Specific txts for some mushrooms – but these are not required often

**USEFUL WEB RESOURCES:**

- Vancouver Mycological Society ([www.vanmyco.com](http://www.vanmyco.com))
- South Van Island Mycological Society ([www.svims.ca](http://www.svims.ca))
  - Identification keys, links
- N. American Mycological Association ([www.namyco.org](http://www.namyco.org))
- E-flora BC (<http://ibis.geog.ubc.ca/biodiversity/eflora/>)
- [MushroomExpert.com](http://MushroomExpert.com)
- [MyokWeb.com](http://MyokWeb.com) (California mushrooms, but used for PNW as well)