

Jan 19 2021

Petri dishes are here. Project outline: I will touch a high touch area with my hands, then use hand sanitizer. Then I will swab my hand with a Q tip and then let the bacteria collected grow on a petri dish. Then I will touch the same area with my hand and then wash my hands according to the Alberta Health services recommendations. Then I will swab my hand with a Q tip and then let the bacteria collected grow on a petri dish. Then I will touch a high touch area with my hands (and I won't use anything) and let the bacteria grow. That will be my control. Materials I will need: Hand sanitizer (at least 60% alcohol), soap, petri dishes, nutrient agar, swabs, high touch area (railing) .

Jan 21 2021

Questions I'm researching: What kind of bacteria lives on surfaces? Effectiveness of hand sanitizer, Effectiveness of soap and water. How does hand sanitizer work? How does soap work? Does water get rid of bacteria?*According to CNA 37 degrees celsius is the best temperature for the bacteria to grow in.

"Up to 80 per cent of all infections are transmitted by hands" (US Centers for Disease Control and Prevention). There are two categories of bacteria living on your hands: resident flora and transient flora. Resident flora is found on the surface of the hand and the first layer of skin. Resident bacteria is not known for causing infections, but can irritate areas like the eye. Staphylococcus epidermidis is the superior species of bacteria in the resident category. Oxacillin, S. hominis, and coagulase-negative staphylococci, are among other bacteria that are living on your hands. These bacteria are harmless though, when outside the body.

Transient flora, also called temporary skin flora, is easily removed with hand hygiene. Transient bacteria lives on the surface of the skin as well, and depending on the type, number of other organisms, and moisture present, can be spread easily. Transient flora is less likely to cause illnesses.

<https://kidshealth.org/staph.bacteria>.

<https://oregonstate.education.5.1-layers-of-skin>.

<https://www.ncbi.nlm.nih.gov/books/NBK144001/>

Alcohol (made up of carbon, hydrogen and oxygen) is the most important ingredient in hand sanitizer. Alcohol, like ethyl alcohol, isopropyl alcohol, or benzalkonium chloride, help kill bacteria by "breaking apart proteins, splitting cells into pieces or messing with a cell's metabolism" according to a review in the journal of clinical microbiology. Alcohol based hand sanitizers need 60-70% alcohol to be effective. There was a study in Europe showing that liquid hand sanitizers work the best. Gel hand sanitizers don't act quickly enough and people often don't use enough hand sanitizer when using the foam sanitizer. Bacteria doesn't become resistant to hand sanitizer, so the effectiveness of it will continue.

<https://www.livescience.com/hand-sanitizer.html>

[https://www.forbes.com/sites/2020/07/31/coronavirus-alcohol-based-hand-sanitiser/?](https://www.forbes.com/sites/2020/07/31/coronavirus-alcohol-based-hand-sanitiser/)

Jan 24 2021

Using only water isn't as effective as using soap because the grease and dirt from everyday activities won't be removed from water alone. Elixirs found in soap helps combine water and oil (found on our hands). The molecules in the soap bond with water and oil, then the molecules

pick up any dirt, bacteria and grease, and hold on to it. Antibacterial soap has been proven to be just as effective as normal soap. But antibacterial soap can kill helpful bacteria. The washing and lathering of the soap is what removes the bacteria and dirt from your hands. When it comes to bar soap and liquid soap, liquid soap is better. Bar soaps can grow bacteria and spread illnesses and germs.

<https://www.hackensackmeridianhealth.org/HealthU/2020/08/11/how-does-soap-work/soap%20molecules%20have.water%20washes%20it%20all%20away>

<https://www.health.state.mn.us/people/handhygiene/how/bestsoap.html>

Jan 28 2021

Testable question: what hand hygiene product is the most effective at getting rid of germs and bacteria? Materials: liquid hand sanitizer (at least 60% alcohol), soap, water, petri dishes, nutrient agar, Q tip

Jan 30 2021

Hand sanitizer can eliminate some types of bacteria and germs, but it might not get rid of all the bacteria on your hands. Hand sanitizer might not be as effective if wiped off before it is able to dry, and/or enough was not used. Hand sanitizers that do not contain at least 60% alcohol are not very effective.

<https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html#:~:text=Many%20studies%20have%20found%20that,based%20hand%20sanitizers%2016%2C20>

*Hand washing washes away bacteria, while hand sanitizer only kills certain types of bacteria.

Vocabulary:

- coagulase-negative staphylococci: a common type of bacteria that lives on skin. This bacteria is harmless when outside the body.
- Staphylococcus epidermidis: a common type of bacteria that lives on skin. This bacteria is harmless when outside the body.
- resident flora: "The microorganisms that usually occupy a particular body site are called the resident flora." (Merck Manual)
- transient flora: Microbes inhabiting a body surface or cavity for a brief period of time

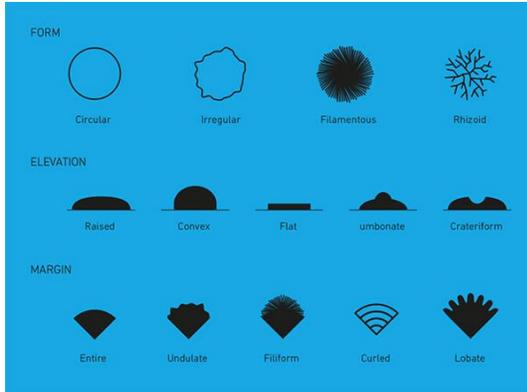
Feb 2 2021

How do I measure bacteria? Bacteria can be measured by either counting the cultures (a population of bacteria) or turbidimetry ("Cell cultures are turbid: they absorb some of the light and let the rest of it pass through. The higher the cell concentration is, the higher the turbidity." -Boundless Microbiology)

<https://courses.lumenlearning.com/boundless-microbiology/chapter/counting-bacteria/#:~:text=Spectrophotometry%20is%20an%20indirect%20method,dishes%20containing%20specific%20growth%20media>

Feb 6 2021

Bacteria can grow in different sizes like the ones below. They fall into different categories.



Picture from Microbiology Society

You must also take into consideration the following: (taken directly from Microbiology society)

- Form – what is the basic shape of the colony? For example, circular, filamentous, etc.
- Size – the diameter of the colony. Tiny colonies are referred to as punctiform.
- Elevation – this describes the side view of a colony. Turn the Petri dish on end.
- Margin/border – the edge of a colony. What is the magnified shape of the edge of the colony?
- Surface – how does the surface of the colony appear? For example, smooth, glistening, rough, wrinkled or dull.
- Opacity – for example, transparent (clear), opaque, translucent (like looking through frosted glass), etc.
- Colour (pigmentation) – for example, white, buff, red, purple, etc.

<https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/bacteria/observing-bacteria-in-a-petri-dish.html#:~:text=Each%20distinct%20colony%20represents%20a n,are%20fairly%20circular%20in%20shape.>

Definition “bacterial culture: The growing of microorganisms on a culture medium, such as agar, in an incubator kept at body temperature, for purposes of identification.” (Medical Dictionary)

Colony morphology is the way scientist put bacteria into categories and how they identify bacteria

<https://www.sciencebuddies.org/science-fair-projects/references/interpreting-agar-plateshttps://medical-dictionary.thefreedictionary.com/bacterial+culture>

Feb 14 2021:

Waiting for 2A form to be approved. I have all my materials.

Feb 18 2021:

Hypothesis - If hand soap contains elixirs that help combine water and oil (found on our hands) that pick up dirt, bacteria and grease, and hold on to it, but hand sanitizer can only eliminate some types of bacteria and germs by "breaking apart proteins, splitting cells into pieces or messing with a cell's metabolism" according to the journal of clinical microbiology, and using only water isn't as effective as using soap because the grease and dirt from everyday activities won't be removed from water alone, then hand soap will be the most effective at getting rid of bacteria.

Instructions for growing bacteria: (taken directly from Home Science Tools)

Fission occurs rapidly in as little as 20 minutes. Under perfect conditions, a single bacterium could grow into over one billion bacteria in only 10 hours!

<https://learning-center.homesciencetools.com/article/bacteria-experiment-guide/>

Feb 22 2021

Procedure:

1. Prepare nutrient agar according to manufacturer's instructions (mix room temperature distilled water and freeze dried nutrient agar. Stir periodically and bring to a boil. An optional step is to autoclave at 121 degrees celsius for 15 minutes. I did not do this step. Then let the nutrient agar cool to 50 degrees celsius. Allow to set for an hour. If not using immediately, store in a cold place so bacteria cannot develop.)
2. Gather all your materials (sanitizer, soap, petri dishes, water, swabs)
3. Touch the high touch area that you chose (I chose a railing and a door knob). Time how long you touch the surface for, so that your tests are consistent.
4. Use enough hand sanitizer to coat your hands (I used approximately 2.5 ml) and allow the sanitizer to dry. Then swab your hands and lightly run the swab on the nutrient agar.
5. Repeat step 3 and then wash your hands according to the guidelines of Alberta Health services, then swab your hands and lightly run the swab on the nutrient agar.
6. Repeat step 3 and wash your hands with only water for 30 seconds. Swab your hand and lightly run the swab on the nutrient agar.
7. Repeat step 3 and do not use any hand hygiene products. Swab your hands and lightly run the swab on the nutrient agar.
8. Seal your petri dishes so no bacteria can get in. Label your petri dishes (which one is hand sanitizer, which one is soap, which one is water, and which one is the control).
9. Let the bacteria grow in a warm dark place.
10. Take pictures of the petri dishes every day and make observations like size, form, border, surface, and the opacity of the colony. DO NOT OPEN PETRI DISHES WHEN MAKING OBSERVATIONS. Bacteria takes 2-7 days to develop.

I have prepared my nutrient agar and it is setting. I will do my experiment tomorrow or wednesday.

Feb 24 2021:

Variables:

Controlled variable: the petri dish that contains the bacteria from when I did not use any hand hygiene product

Independent variable: the petri dishes with the bacteria from when I only used hand sanitizer, when I only used soap and water, and when I used just water.

Dependent variable: the amount of bacteria that grows on the petri dish when I only used hand sanitizer, when I only used soap and water, and when I just used water.

March 2 2021

I started my experiment Saturday.

OBSERVATIONS

Test # and Hand Hygiene Product	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
T1 Soap	No change	No change	There are 2 punctiform bacteria cultures, 2 0.5cm bacteria cultures and a 0.9cm bacteria culture	There are only 2 bacteria cultures visible. One measuring 0.7cm and the other 0.4cm	There are 2 larger bacteria cultures measuring 1.4cm and there is one medium sized culture measuring 0.8cm	The biggest bacteria culture is 1.5cm. There are opaque cultures and 1 translucent culture.
T1 Sanitizer	No change	No change	There are a few punctiform bacteria cultures on the petri dish	No change has happened.	The cultures are scarcely visible and are only 0.1cm	Unlike the other petri dishes that have developed opaque cultures, this one only has translucent cultures. Also, this petri dish is only growing small cultures (this may be from the way I swabbed my petri dish)
T1 Water	No change	No change	There are a few punctiform bacteria cultures on the petri dish	There are 2 small beige bacteria growing. The biggest is 0.5cm	The biggest culture is 0.6cm and the rest are punctiform cultures	The biggest bacteria culture is now 1.3cm. I have noticed a tiny red bacteria culture. It's

						smaller than 0.1cm. Only the T2 water has a red bacteria culture.
T2 Soap	No change	No change	There are about 3 punctiform bacteria cultures	There are multiple beige bacteria cultures, the biggest measuring 0.4cm	There are only 5 cultures bigger than 0.1cm and the largest of them all measures 0.5cm	The biggest bacteria culture is 1.3cm. This petri dish has a small green culture that has developed.
T2 Sanitizer	1 small beige bacteria culture is visible	There are now 4 beige bacteria cultures on the petri dish the biggest measuring 0.7cm	There are many punctiform bacteria cultures developing. The biggest bacteria culture is 1cm	The biggest bacteria culture is now 1.2cm and is the largest amongst all the petri dishes.	The largest bacteria culture is 1.5cm. There are only 4 other bacteria cultures measuring over 0.1cm	The biggest culture measures 1.5cm and is the biggest culture among all the petri dishes. There are 7 other cultures measuring 0.1cm to 0.5cm
T2 Water	1 small beige bacteria culture is visible	The bacteria culture measures 0.2cm	The biggest bacteria culture is 0.5cm. There are many other bacteria cultures growing	There are multiple small bacteria cultures, and one is a neon green like the ones in the nothing petri dish. This means that the water did not wash away the green bacteria.	Up to this point the margins of the bacteria cultures were all entire, but this petri dish has developed a bacteria culture with a filiform margin. A green bacteria culture has also developed. It is the only petri dish besides the nothing one that has	This petri dish has the most variation of colours of bacteria. It has one red culture, one green/yellow culture and several beige cultures. This petri dish also has the only bacteria with a filiform margin so far.

					developed green bacteria	
T3 Soap	No change	One small bacteria culture appeared on the petri dish measuring 0.2cm	There are many punctiform bacteria cultures growing, but only one large one (measuring 0.4cm)	There are numerous tiny beige cultures; the biggest is 0.5cm. The rest are punctiform cultures	Now there are 2 cultures measuring more than 0.1cm. There are many punctiform cultures that have developed.	This petri dish has 2 bacteria cultures measuring over 0.1cm. Unlike the other soap petri dishes, this one hasn't developed as many large cultures.
T3 Sanitizer	No change	4 tiny beige bacteria cultures grew on the petri dish all about the same size	There are about 4 bacteria cultures growing, all beige	There are many punctiform bacteria cultures none measuring more than 0.1cm.	Still no bacteria cultures measuring over 0.1cm. All the cultures grown so far are beige.	This petri dish does not have any cultures over 0.1cm. But unlike the other sanitizer petri dishes, this one has more miniscule cultures.
T3 Water	No change	No change	No change	This petri dish is almost identical to the sanitizer petri dish. There are many beige cultures, none measuring more than 0.1cm	There are 2 beige cultures that are 0.1cm. There are a few beige cultures scattered around the petri dish that are under 0.1 cm	There are two medium sized bacteria cultures measuring 0.5cm and 0.7cm. There aren't as many miniscule cultures.
Nothing	2 punctiform beige bacteria cultures are visible	The petri dish appears to be foggy (possible from condensation on the petri	There are numerous bacteria cultures growing. There is a mix of beige	Unlike the other petri dishes that are growing multiple small cultures and 1 or 2 larger ones, this petri dish is only growing	This petri dish is still not growing large cultures. The biggest culture is	This petri dish has developed a translucent culture that is 0.5cm the biggest culture yet. I

		dish lid), and there are multiple very small bacteria cultures growing.	bacteria and a neon green/yellow bacteria growing.	punctiform bacteria cultures. All the other petri dishes have beige bacteria, while this one has beige and mostly green /yellow bacteria. This means that the soap, water and hand sanitizer removed the majority of the green/yellow species of bacteria.	0.2cm. The margins on these bacteria cultures are only entire.	could not have seen this culture prior to today because you must place the petri dish in a bright light for it to be visible
--	--	---	--	--	--	--

March 3 2021:

edited hypothesis: **Which works best for removing bacteria**

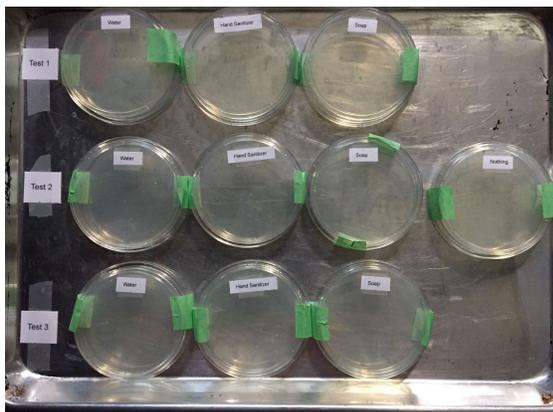
Hand soap contains elixirs that helps combine water and the oil found on our hands which picks up and holds onto dirt, bacteria and grease.

Hand sanitizer only eliminates some types of bacteria and germs by “breaking apart proteins, splitting cells into pieces or messing with a cell's metabolism” according to the journal of clinical microbiology.

Water alone isn't as effective as using soap because the grease and dirt from everyday activities won't be removed (water and oil don't mix).

Based on these facts, hand soap will be the most effective at getting rid of bacteria.

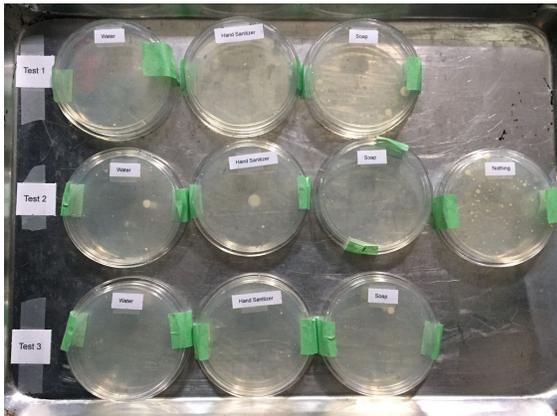
Day 1



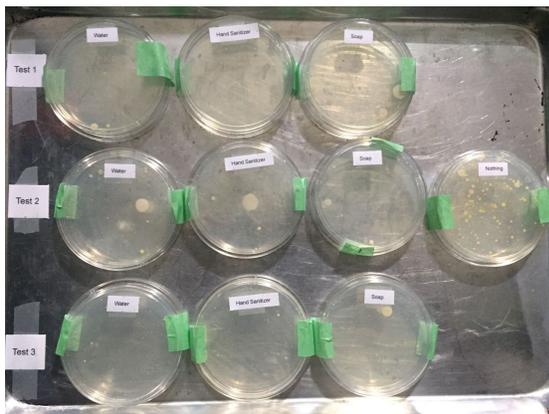
Day 2



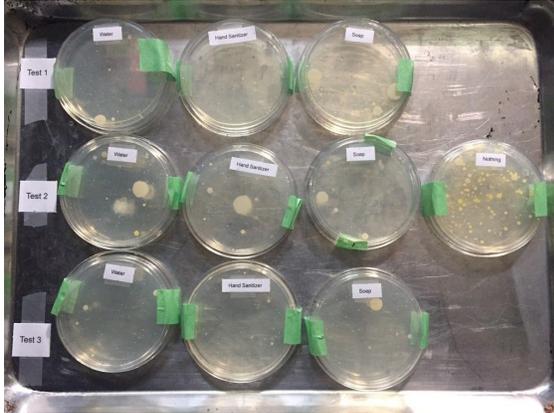
Day 3



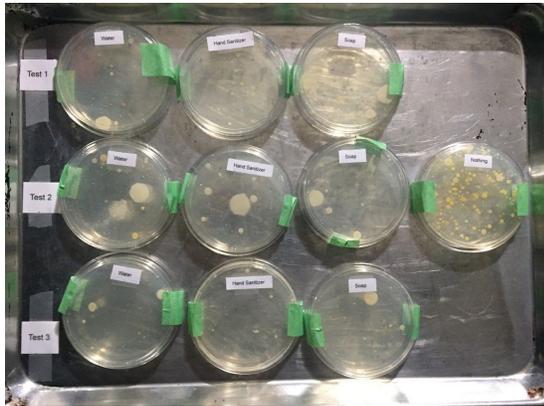
Day 4



Day 5



Day 6

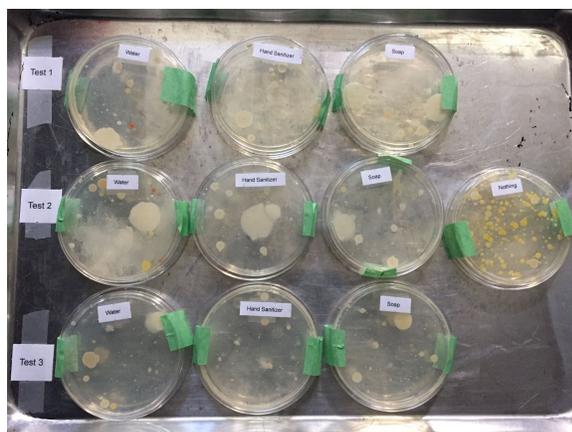


March 8 2021

Day 7: Results

Type of hand Hygiene Product used	Number of Bacteria Cultures bigger than 0.1cm	Color of Bacteria Cultures	Diameter of Biggest Bacteria Culture	Form of Bacteria Cultures	Margin of Bacteria Cultures
T1 Hand sanitizer	18	Beige	0.8 cm	Circular, irregular and rhizoid	Entire and undulate
T1 Soap	38	Beige	1.8 cm	Circular and irregular	Entire, undulate and lobate
T1 Water	13	Beige, light green, red	1.5 cm	Circular, irregular	Entire, undulate, filiform

T2 Hand sanitizer	11	Beige	3 cm	Filamentous, circular, irregular	Entire, undulate, filiform
T2 Soap	14	Beige	1.7 cm	Circular, irregular, rhizoid	Entire, filiform
T2 Water	14	Beige, light green, red	6.8 cm	Circular, irregular, rhizoid	Curled, entire, undulate
T3 Hand sanitizer	16, and a ring of bacteria on the edge of the petri dish	Beige	0.5 cm	Circular, irregular, filamentous	Entire, filiform
T3 Soap	10	Beige	1.1 cm	Circular	Entire
T3 Water	7	Beige and light green	1 cm	Circular, irregular	Entire, undulate
T3 Nothing	About 66	Beige and light green	1.3 cm	Circular, irregular	Entire, undulate



March 9 2021

Application

This experiment can be applied in our everyday lives. Sometimes we don't know if we should use hand sanitizer, soap and water, or just water. This experiment helps with that decision. Especially during these times, when hand hygiene is crucial, this experiment tells us which hand hygiene product is the most effective at removing bacteria. So hopefully, this experiment has informed you on which product you should use next time.

March 10 2021

In my hypothesis I predicted that hand soap would be the most effective at getting rid of bacteria. I found that the hand sanitizer petri dishes grew the least bacteria overall. The soap petri dish, however, grew quite a bit of bacteria. All the hand soap petri dishes only had beige/cream coloured bacteria. This could mean that the hand soap got rid of all the bad bacteria, while keeping the good bacteria. The hand sanitizer got rid of all the bad bacteria as well, but killed some of the good bacteria. The water petri dish grew red, green and beige bacteria, so it was not as effective at removing bacteria as the other two hand hygiene products. I did not expect the soap to grow much bacteria at all, but I did not take into account that the soap may not remove the good bacteria living on our hands. I also thought that the hand sanitizer would have a variety of bacteria cultures, but it did not. I was very surprised that the water petri dishes grew red bacteria, while the nothing petri dish only grew beige/cream and yellow coloured bacteria. Next time I would like to find out what the names of the bacteria living on the petri dishes are, and if they are good/bad bacteria.

March 15 2021

Application (edited): This experiment can be applied to our everyday lives. When having the choice to wash your hands, or use hand sanitizer it is helpful to know which method is the best. Especially during this global pandemic when all leading health experts (WHO, Health Canada, CDC) are recommending regular and thorough hand hygiene frequently during the day, people can choose which hand hygiene product to use based on its effectiveness. People are interested in knowing whether hand sanitizer, soap and water, or just water is most effective at cleaning hands. Now you know you are able to use either hand sanitizer or soap and water as they have the same effectiveness.

March 16 2021

Conclusion: In conclusion, my hypothesis was incorrect. The hand sanitizer eliminated the most bacteria, but, I believe it eliminated some of what I think is beneficial bacteria as well. The hand soap removed all of the bad bacteria, while also keeping (what I think is) the good bacteria. The water was the least effective because it had the most variation in bacteria colour, and had the most bacteria (other than the nothing petri dish). While hand sanitizer and soap/water were equally effective, the hand sanitizer eliminated (what I think is) the good bacteria as well as the bad bacteria. I believe that the hand sanitizer and the hand soap were equally effective because of the bacteria that I had on my hands when I did the experiment.

March 17 2021

Staphylococcus is a yellow bacteria (on the petri dish). It is probably the bacteria that grew on my petri dish since it is a very common type of bacteria. Staphylococcus can be helpful by reducing skin inflammations, by if it gets inside your body, it can cause an infection.

<https://www.newscientist.com/article/dn18184-friendly-bacteria-keep-your-skins-defences-in-check/>

I could not find the name of a beneficial or good bacteria that is beige that lives on hands. I still think that the bacteria growing on the petri dishes is the good kind that you need.

Application (edited 2)

References:

Roque, C. (Ed.). (2019, July). Staph Infections (for Parents) - Nemours KidsHealth. Retrieved January 28, 2021, from <https://kidshealth.org/en/parents/staphylococcus.html#:~:text=Staph%20is%20the%20shortened%20name,wound%20and%20cause%20an%20infection>

Biga, L., Dawson, S., Harwell, A., Hopkins, R., Kaufmann, J., LeMaster, M., . . . Runyeon, J. (n.d.). 5.1 Layers of the Skin. Retrieved January 28, 2021, from <https://open.oregonstate.edu/aandp/chapter/5-1-layers-of-the-skin/#:~:text=The%20stratum%20corneum%20is%20the,cells%20in%20the%20stratum%20corneum>

Normal bacterial flora on hands. (1970, January 01). Retrieved January 28, 2021, from <https://www.ncbi.nlm.nih.gov/books/NBK144001/>

Hickok, K. (2020, March 06). How does hand sanitizer work? Retrieved January 28, 2021, from <https://www.livescience.com/hand-sanitizer.html>

Chamary, J. (2020, August 03). How Much Alcohol Do You Really Need In Hand Sanitizer? Retrieved January 28, 2021, from <https://www.forbes.com/sites/jvchamary/2020/07/31/coronavirus-alcohol-based-hand-sanitiser/?sh=5202760c3a6f>

How Does Soap Work? - COVID-19, Featured, Health Topics, Men's Health, Women's Health. (2020, August 11). Retrieved January 28, 2021, from <https://www.hackensackmeridianhealth.org/HealthU/2020/08/11/how-does-soap-work/#:~:text=%E2%80%9CPin%2Dshaped%20soap%20molecules%20have,water%20washes%20it%20all%20away.%E2%80%9D>

Which Soap is Best? (n.d.). Retrieved January 28, 2021, from <https://www.health.state.mn.us/people/handhygiene/how/bestsoap.html>

Show Me the Science – When & How to Use Hand Sanitizer in Community Settings. (2020, September 10). Retrieved January 28, 2021, from <https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html#:~:text=Many%20studies%20have%20found%20that,based%20hand%20sanitizers%2016%2C20>

Nall, R. (n.d.). Healthline (1169213557 876982801 D. Murrell, Ed.). Retrieved January 28, 2021, from <https://www.healthline.com/health/coagulase-negative-staph>

Merck Manual: Consumer version <https://www.merckmanuals.com/en-ca/home/infections/biology-of-infectious-disease/resident-flora#:~:text=The%20microorganisms%20that%20usually%20occupy,permanently%20are%20called%20transient%20flora>

Society, M. (n.d.). Observing bacteria: Bacteria. Retrieved February 03, 2021, from

<https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/bacteria/observing-bacteria-in-a-petri-dish.html#:~:text=Each%20distinct%20colony%20represents%20an,are%20fairly%20circular%20in%20shape.>

Bacterial culture. (n.d.). Retrieved February 03, 2021, from <https://medical-dictionary.thefreedictionary.com/bacterial+culture>

Science Buddies. (2020, February 07). Interpreting plates. Retrieved March 09, 2021, from <https://www.sciencebuddies.org/science-fair-projects/references/interpreting-agar-plates>

Geddes, L. (2009, November 23). Friendly bacteria keep your skin's defences in check. Retrieved March 17, 2021, from <https://www.newscientist.com/article/dn18184-friendly-bacteria-keep-your-skins-defences-in-check/>