Dressing for Survival

Genetic engineers may someday enable us to grow winter coats of fur. Until then we will need an artificial substitute—clothing—to survive in cold weather.

Clothing, like fur, controls heat transfer by controlling the layer of air around the body. Air is an excellent insulator, so trapping it against the skin keeps heat in. Conversely, venting and circulating warmed air away from the skin carries heat away. Since our body's heat production can increase up to ten-fold when we are exercising hard, we often have to get rid of heat even in cool weather.

Water is an excellent conductor, and it can also absorb far more heat than air. If water displaces the trapped air around the skin, it will turn clothing into a refrigerator. Clothing, therefore, needs to control the movement of water as well as air. Keeping rainwater and snow out would be a simple function to design into clothing, if it did not also have to allow our sweat to evaporate into the air. Performing both these functions during active use requires clothing to have good design and the right materials.

The Right Stuff

Wool keeps sheep warm and dry, but sheep have oil glands that keep the fibers water-repellent. We have only the oil that is left in wool after manufacture. "Virgin" wool is best, especially if it comes from sheep that grew up in cold and wet surroundings. "Oiled wool" has some of the oil lost in processing restored to the fibers. Wool garments can absorb up to half their weight in water, although they may not feel wet until they are 35% to 50% saturated. Also, wool dries very slowly. These limitations make wool best for clothing in which its toughness and resilience count: long-wearing socks, durable mittens, and tightly woven pants or shirts.

Cotton can quickly soak up 100% of its weight in water, and it loses 90% of its insulating value when wet, so it makes good bath towels but terrible cold-weather clothing. Down-filled garments are tempting because down's springy plumules expand more and trap more insulating air than any other material of the same weight. But down, like cotton, has high affinity for moisture and loses almost all of its insulating power when wet. Down clothing is, therefore, most useful in arctic conditions where it is unlikely to get wet, and its warmth-to-weight ratio significantly lightens the burden of clothing.

Silk absorbs about 20% of its weight in water, so it makes a better inner layer than other natural fibers, and some people like the feel of it next to their skin. But it usually requires hand washing, and does not perform as well as synthetics. Synthetic fibers have much more survival value than natural fibers in cold and wet weather, because they absorb very little water. Nylon absorbs only 4% of its weight in water, while polyester and polypropylene absorb 1% to 2%. If these fabrics get soaked, they feel clammy, but do not lose much insulating value. They dry out very fast, because the water does not wet the fibers in the fabric. In natural fabrics, by contrast, water bonds to the fibers, displacing trapped air bubbles.

Layering

Clothing for the body and limbs should be layered, so that it can easily be added or taken off to fit conditions and activity level. The inner layer should be stretchy, so that it hugs the body without binding, and should allow sweat to move freely through its fibers ("wicking off"). The middle layers are insulation, stabilizing the layer of air warmed by body heat next to the skin. They should also allow sweat to pass through. The outer layer, or shell, is designed to keep wind and water out. But like the other layers, it must allow evaporated sweat to escape. These conflicting functions make an effective shell the most difficult layer to design and sew.

The Inner Layer

Specially knit polyester has largely replaced polypropylene for winter underwear, because polyester does not pick up body odor so easily, and it is less likely to shrink or pill in the wash. It comes in several thicknesses, from lightweight (for active use in moderate temperatures) to expedition weight (for severe cold). Polypropylene fishnet, made in Norway by Super Brynje, is an excellent inner layer because it gives a lot of warmth for its weight. The open mesh allows sweat to escape, which makes it comfortable over a large range of temperatures and activity levels. It can be worn under a layer of regular synthetic underwear. Some people prefer a wool inner layer because it doesn't feel wet until it has absorbed quite a bit of water, but it has less survival value than a synthetic layer, because it is harder to dry.

Insulating Layers

For active use, these should usually be of polyester pile or fleece. Fleece is synthetic fur with a short nap, inside and out. Its most common brand name is Polartec®. Microfleece or regular fleece with a wind-proof layer is more expensive but useful in cold and windy conditions where it may be enough protection by itself when you are moving. Wind-Pro® is more tightly knit Polartec®, which has about four times the wind resistance, but is more breathable than Polartec® with a wind-proof layer sandwiched inside. Polyester is also used as fill, like down, for jackets that are sewn into compartments. These are good for staying warm when you're not moving but not so good for active use, because they do not vent sweat or excess heat or dry as easily as fleece or pile.

Outer Layer: Wind and Rain Shell

Shells (parkas or anoraks, and rain pants) are of nylon or polyester, with a water-repellent layer laminated inside. To protect the water-repellent layer, they have either another layer of fabric laminated to the inside or a liner. They may also have a waxy coating sprayed or washed onto the outer layer that resists wetting. Since a good wind and rain shell is expensive, you should check its design and construction carefully before buying.

- How many layers are there? The minimum is two: a water-repellent film laminated inside the fabric. The exposed film can easily be worn away as your body rubs against it. Three layers are best — stretchy nylon tricot laminated inside over the water-repellent film. Many parkas have a liner instead of the inner layer, stitched only at the seams and hanging loose.
- Look at the seams, inside. They should all be sealed with waterproof tape. Look closely at tape intersections, because that is where tape most often delaminates. Seam tape is laminated by heating it to a temperature very close to the melting point of nylon, so the temperature of the heating element needs to be controlled precisely. If the garment has a liner, you won't be able to expose the seams, but you might be able to see and feel them through the outer fabric.
- How thick and tough is the outer layer? A thin fabric will save weight, but then the water-repellent layer inside can more easily be shredded by abrasion, e.g., by sliding down a snow slope, even if the outer layer isn't cut.
- What happens when you move? When you turn your head, does the hood turn with you or does it blind you? When you raise both arms, does the parka hike up halfway to your armpits?
- Is there a wind skirt, which you can cinch around your waist to prevent wind and rain from blowing in from below?
- Check the zippers. The front zipper should be 2-way, and the armpit zippers (essential) should be long enough for you to slip your arms through them and tuck the sleeves inside the parka. Most water-repellent layers on garments, like Gore-Tex®, are more or less breathable, because they have microscopic pores to let out the water vapor of evaporated sweat. However, if you are sweating heavily, you will quickly saturate the pores. Then you need the pit zips to vent steam.
- Heavy rain or wet snow will also prevent evaporation by saturating the outer layer of the garment with water, though this layer can be made more water repellent by treating it with a spray such as Nik-Wax®.

Consider the useful life of the garment. Gore Associates claims a lifetime of about eight years for its product under normal use, and ten years under little or no use. Other manufacturers of similar waterproof layers claim similar lifetimes for their products. If you do serious outdoor activities in extreme conditions where your survival may depend on your clothing, then you need high quality outerwear. And if you spend much of the year outdoors, the comfort and safety margin of the best outerwear is still a good investment. But for occasional trips in moderate conditions where you have an easy escape route, cheaper outerwear may be adequate. If you're huddling in the rain, or just doing day hikes on an easy trail, advanced design features aren't going to make much difference.

Head, Hands, and Feet

For head protection, the hood of your parka should fit comfortably over your head insulation. A warm cap of synthetic or wool that pulls down over the ears and a lightweight balaclava that can cover the whole head and neck are a good combination. For very cold, windy conditions, a neoprene facemask may be needed.

For the hands, synthetic glove liners, gloves or mitts of wool or synthetic, and water-repellent overmitts are the three layers. The middle and outer layers are often combined into insulated gloves, but on a backcountry trip, these are hard to dry out when they get wet. Glove

liners are essential so that you won't be exposing bare skin when you need full use of your fingers.

For the feet, leather boots require preparation to make them waterproof. First, seal all seams, especially in the welt (connecting the uppers and the soles), with a liquid such as Stitch-Lock. This saturates the threads and makes them swell, sealing the stitch holes. Then seal the leather uppers by rubbing in a waterproofing compound for leather — many are available. Plastic ski and mountaineering boots are insulated with foam. If they don't fit well, they can pinch and impair circulation.

For cold winter skiing or mountaineering, gaiters should completely cover the boots and have pockets inside to insert insulating foam. Inside the boots, you need thin, synthetic inner socks that cling to the foot and protect the skin from abrasion. Thick wool or synthetic socks provide insulation, but be careful not to cram so many socks in the boots that you cut off circulation. To reduce heat loss by conduction through the bottom of the boot, add an insole of foam neoprene.

Vapor Barrier Liners

Since we lose heat by insensible sweating, even in cold weather, some people use waterproof liners between layers. For example, one plastic produce bag between the inner and outer sock, and another between the outer sock and the boot, seals in sweat and keeps the insulating sock dry. Similarly, a plastic liner can go between glove liners and mitts. For the body, a thin waterproof shirt or jacket goes just over the synthetic underwear. Some people have more tolerance than others for the clammy feeling of vapor barrier liners, but they are seldom used during vigorous activity unless the temperature is below freezing.

Putting It All Together

When selecting cold weather clothing, bring along the other layers that you will be wearing with it to make sure that they will fit together comfortably. If you will be snow camping, try lying down and turning over a few times, because you will probably be wearing at least some layers in the sleeping bag. Do the clothes stretch and move with you, or do they bind and shift?

Cold weather clothing has not quite caught up with the natural insulation that caribou and wolves have evolved. But by knowing how clothing works, and selecting clothes that fit our activities as well as our bodies, we can survive and even enjoy winter weather.

Sleeping Warm

Getting chilled at night can lower your resistance to hypothermia, altitude illness, and respiratory infections, as well as make you more susceptible to accidents the next day by reducing your physical and mental efficiency. So making sure that you sleep warmly and comfortably is good preventive medicine. Your choice of sleeping bag and insulating pads can make a big difference, but certain tricks can help you make the most of equipment.

Preparing the Ground

Avoid tall grass, because on a cool night it will collect a lot of dew, and so will your sleeping bag or shelter. Also avoid the bases of big gullies or descending valleys that can turn into wind tunnels as cold air flows down them at night. In a snow shelter, sleep on a shelf with a deeper trench beside it to collect and carry out the cold air. When digging a snow shelter, wear only the minimum of synthetic layers under your outer layer to keep you warm while digging. Then put on more layers when you finish digging.

Down vs. Synthetic Sleeping Bags

High quality goose down has the most loft of any sleeping bag fill, and so gives the most warmth for the weight. But it collapses when wet; and because it is so compressible, it provides very little ground insulation under the body. As a result, you may need more thickness of foam pad underneath you than with a synthetic bag. As a result, down bags work well in dry climates, including arctic conditions, but have little survival value in climates where they can get wet. If you take good care of a down bag, it will last for many years. Don't keep it stuffed any longer than necessary. Never dry-clean it, because the chemicals strip the natural oils from the down plumules and make them less springy, reducing the down's loft. Some laundries specialize in washing and drying down bags in large drum-type machines.

Synthetic bags are filled with fibers, usually polyester, that are crimped at a temperature of about 160° F to give them loft. They are heavier and bulkier than good down for the warmth they give. Also, they can lose loft if they are kept stuffed, especially in a hot car. Keeping them in loose storage sacks extends their life.

The advantage of synthetic bags is that the fibers do not absorb moisture, so they keep most of their loft and warmth even when the bag gets wet. Also, since they are less compressible than down, they provide more ground insulation. Most fibers now used for fill are hollow, which gives them more insulating trapped air at a

lighter weight. Polarguard® (matted fibers used for furniture) is now probably the most common synthetic fill for sleeping bags. Unlike loose fills, it doesn't spill if the shell is torn.

Dressing for Sleep

You can sleep warmer and get by with a lighter sleeping bag by wearing clothes inside it, but they need to be the right kind of clothes—stretchy synthetics. These clothes will not wrinkle or bind, and will also not absorb water from your sweat. An inner layer of synthetic underwear and a fleece pullover or jacket work well. Dry socks will keep your feet warm — it is impossible to feel warm if your feet are cold. A fleece cap or balaclava will prevent heat loss through your head. As you warm up inside the bag, you can remove layers of clothes. In very cold weather, some people use vapor barrier liners (VBLs) inside their sleeping bags — bags of waterproof nylon that prevent evaporative heat loss by sweating and keep the moisture out of the insulation. The disadvantage is that VBLs may make you feel damp and clammy, even if you wear your synthetic underwear.

Breath, Fuel, and Water

When you breathe dry air, your circulatory system humidifies it with water from a network of blood vessels in the air passages, and you lose most of that moisture when you exhale. If you breathe inside your bag, that water will soak into the bag's insulation. So you should always keep your mouth and nose out of the bag, even when you cinch up the hood around your head.

Inside a tent, you should always have some back-to-front ventilation that will carry your warm, moist breath outside. Ideally, cold air comes in through the low vent at your feet and warmed, moistened air rises to pass out the higher front vent. Otherwise, the moisture will condense on the tent fabric and rain down on your bag. Even a synthetic bag feels unpleasant when it gets clammy.

Digestion generates heat, so eating a good dinner will help keep you warm at night. You also need to be well hydrated, because dehydration can reduce blood volume. This in turn can slow down heat-generating metabolism and impair circulation to the hands and feet, making them feel cold. But if you let yourself get dehydrated all day then tank up before crawling into the sleeping bag, that guarantees some late night excursions to empty your bladder, which on a cold night can chill you down fast. Caffeine and alcohol before sleeping can also send you out with a full bladder, because they are diuretics. But a plastic pee bottle can save you a cold excursion.

Insulating Pads

Closed cell foam pads are the most reliable ground insulation. Several models are available with patterns of ridges or nubbins that increase the effective insulation for the weight and bulk. Thermarest® pads are inflatable, which adds insulating air to the foam inside. Their drawbacks are that they can be punctured and start leaking (so it is important to carry a patch) and the valve can fail. Also, the nylon shell is slippery, even if you spray it with an aerosol that makes it a bit tacky, so you can slide off it at night, especially if the ground under you is not quite level. The advantage is that it gives you much more insulation than a closed cell pad for its weight, and that it conforms more to your body, like a mattress. So it is less likely to impair circulation. For a very cold winter trip, a three-quarter length Thermarest® and a full-length closed cell foam pad is a good combination.

A small pillowcase of soft-textured nylon can be stuffed with any soft surplus clothing. Or you can make a pillow by zipping up a fleece or pile jacket, turning it inside out so that the sleeves are inside, then folding it with the zipper on the bottom.

Tibetan Tuck and Penguin Huddle

What if you are caught in the open with no shelter or sleeping bag? Then you can use the Tibetan tuck and the penguin huddle to survive. Tibetan pilgrims use these heat-conserving positions to sleep without shelter in sub-freezing, windy mountain passes.

To do the Tibetan tuck, face away from the wind and kneel on whatever insulation you have. Put your head on your knees and wrap your hands around your head. Wrap something around your hands and head if possible. If you are in a group, you can do the penguin huddle. Sit on whatever insulation you have with your back to the wind and your legs comfortably flexed so that only your boot heels are in contact with the ground. Then have the rest of the group sit in front of you between each other's legs, wrapping their arms around each other to conserve body heat. From time to time, the person to windward moves to the downwind side.

Figure 1.1 The Tibetan Tuck (with your rear to the wind) is a survival posture used by Tibetan pilgrims caught in cold and windy mountain passes without shelter.

Photo courtesy Joanne Clapp Fullagar

Figure 1.2 The penguin huddle is a survival posture for a group. The windward person moves to the front when he gets cold.

Photo courtesy Joanne Clapp Fullagar

Figure 1.3 If you're caught alone in an exposed place, wrap yourself in a tarp and sit on something insulating.

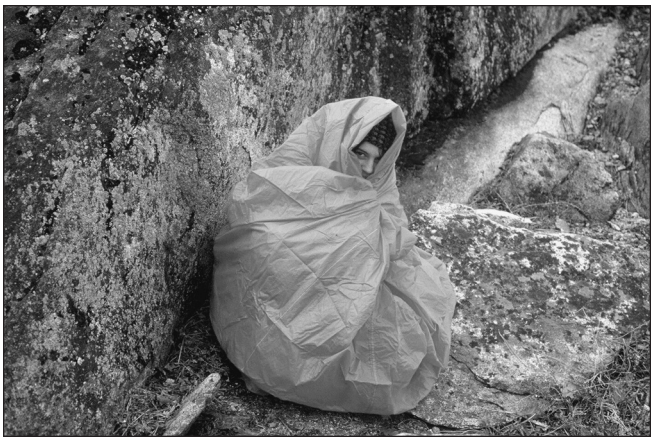

Photo courtesy Ben Schifrin, M.D.